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GROWING OLD AS A ROCK STAR: A FOUR-PART STUDY OF THE AGING VOICE

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GROWING OLD AS A ROCK STAR: A FOUR-PART STUDY OF THE AGING VOICE

DISSERTATION

A dissertation submitted in partial fulfillment of the
requirements for the degree of Doctor of Philosophy in the
College of Health Sciences at the University of Kentucky

By
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ABSTRACT OF DISSERTATION

GROWING OLD AS A ROCK STAR – A FOUR-PART STUDY OF THE AGING VOICE

This dissertation focuses on the aging voice - specifically the aging elite vocal athlete. It is comprised of four components; a series of research studies and a viewpoint piece designed to explore the awareness, struggles, and vocal compensations of aging singers dealing with age related vocal and performance problems. The overarching goal of these studies is to inform the development of a voice care protocol for the aging rock star to guide customized intervention for these elite vocal athletes that is focused on optimizing both vocal output and performance.

First, the dissertation introduces and identifies characteristics of the exceptional voice. This involves a new vocal continuum that includes the normal voice, the trained voice, and the exceptional voice. The second component is a qualitative study of older contemporary commercial music (CCM) singers adjustments and accommodations associated with their aging. From this, four overarching themes are identified: modest self-perception of their vocal prowess and its relationship to performance, acute sensitivity to changes in vocal quality, recognition of the critical association of voice quality with their identity as a performer, and an array of accommodations to aging-related vocal changes.

The third component of the dissertation is a randomized control trial examining the efficacy of Vocal Function Exercises as a treatment modality for presbyphonia. Analysis revealed that the experimental group improved in select outcome measures including decreased glottic gap, increased upper range, and maximum phonation time at the 6-week post-treatment re-evaluation with no such changes in the control group. The final study investigated the vocal and performing trajectories of six CCM male singers through analysis of video performances across their career. Singers were shown to make accommodations consistent with the reported findings from component two. Such accommodations include decreased total time singing for some singers, accommodations for range changes, and changes to performance. From this study, the *Exceptional Voice Protocol* was created to provide a customized vocal and performance blueprint for each artist that meets their unique needs for their exceptional voices.

Overall, this research indicates that aging CCM singers appear to be experiencing age and performance related vocal changes and are making detectable accommodations to their performance. Additional findings show that Vocal Function Exercises appear to be an efficacious treatment modality for aging voice. Findings from these studies confirm the need for continued research on age-related vocal and performance changes for these performers and guidelines for appropriate habilitation and rehabilitation so these rock stars can continue performing for as long as they desire.

KEYWORDS: presbyphonia, presbylaryngeus, aging elite vocal athlete, Vocal Function Exercises, voice therapy, exceptional voice

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PROLOGUE

An important step in the process of qualitative research is for the researcher to acknowledge any biases that may color their work. This is often done through reflexivity to enhance the trustworthiness, transparency, and accountability of the research. Therefore, I must share my past education and experiences that have shaped me into the researcher and clinician I am today.

I received a BA in music studying voice and piano from Methodist University and a MA in Communication Sciences and Disorders from the University of Memphis. I completed a clinical fellowship focusing on voice and upper airway disorders at the University of Kentucky Voice & Swallow Clinic, where I am currently the singing voice specialist. I provide evaluations and treatment for elite vocal athletes as well as general voice and upper airway disorders. I also have extensive training and experience in both classical and contemporary commercial music (CCM) genres and vocal pedagogy. I have performed extensively as a musical theater performer and dancer having taught both genres for over 20 years. I continue to run a private studio focusing on training performers for careers in the arts. I am currently adjunct faculty at Eastern Kentucky University teaching voice disorders and a voice consultant for Gray Television providing professional vocal coaching for on-air personalities.

This training and these experiences have undoubtedly shaped my awareness, understanding, and insights in to the age-related vocal and performance changes in elite vocal athletes. During the research for this dissertation, I have acknowledged my biases and worked to keep the research grounded in the words, experiences, and performances of the elite vocal athletes.

CHAPTER 1: INTRODUCTION

As contemporary commercial music (CCM) singers, or elite vocal athletes, approach the final phases of their careers, they often find themselves experiencing potentially traumatic and career influencing vocal and performance related changes as they age. These vocal changes are experienced by many people as they age but are often felt earlier by these singers and subsequently have the potential to significantly impact their lives. Although there is extensive research on younger singers related to voice disorders, there is currently limited research on vocal and performance related changes due to aging in the CCM population.

As they enter the final scene of their performing careers, older singers often struggle with acknowledging and accommodating to changes in their aging voice; and develop anxiety about being able to perform as they did during the peak of their careers. Like professional sporting athletes, elite vocal athletes are challenged by age to maintain the necessary physical skills to sustain their professional performing careers. Singing is no easy task; it requires a balanced interaction among the three subsystems of voice production: respiration, phonation, and resonance. Elite vocal athletes have voices that are different than the general population; voices that are special. They are without question, a vocally unique group with exceptional voices. It is known that elite vocal athletes of all ages are at increased risk for developing voice problems due to their profession compared to the general population. As the anatomy inherent in all three subsystems of voice production age, voice quality often diminishes in spite of good vocal hygiene habits, directly impacting the performance career of aging elite vocal athletes. Although singers often seem larger than life and invincible, they are not superhuman, raising the main question of this research, *What can be done to strengthen and sustain the singing voice for these aging singers to lengthen their performing careers and optimize their vocal health?*

Elite vocal athletes are a subset of the aging voice population and treatment and concerns for them are very different than for the non-singer and need to be researched further regarding the implication of normal aging voice changes. The loss of the singing voice due to aging may seem inconsequential; however, emerging data shows that those facing this reality may find it career halting with significant financial implications that are far-reaching beyond just the performer.[1] The current state of the literature suggests that there is limited data regarding this issue.

This dissertation is comprised of four components; a series of research studies and a viewpoint piece designed to explore the awareness, struggles, and vocal compensations of aging singers dealing with age related vocal and performance problems. The overarching goal of these studies is to inform the development of a voice care protocol for the aging rock star to guide customized intervention for these elite vocal athletes that is focused on optimizing both vocal output and performance.

Dissertation Stages

Component I Primary Objective – Defining the Exceptional Voice

The primary objective of Component I was to address a practical problem that singers seeking voice rehabilitation in a clinical setting often encounter: lack of health insurance coverage. Currently, the accepted definition of a voice disorder is not broad enough to encompass the social, emotional, and financial implications of voice problems experienced by elite vocal athletes. These vocal difficulties are often not considered a health risk and the treatments are often deemed by medical providers as "not medically necessary." Because of this thinking, the clinical support system routinely fails these performers due to health insurance coverage exclusions.

Component I Rationale:

To address this problem, a new definition of a voice disorder is proposed, with the goal of expanding the profession's view of voice disorders across the voice production continuum to include the elite vocal athlete. Specific recommendations for the rehabilitation and habilitation of the exceptional voice are suggested.

Component II Primary Objective – The Aging Exceptional Voice: In Their Own Words

The primary objective of Component II was to explore the perceptions of professional singers as they experience and accommodate to age related vocal and performance changes.

Component II Rationale:

This qualitative study employed a content analysis of 73 autobiographies and explored the perceptions of CCM singers as they experience and accommodate to potentially traumatic and career influencing vocal and performance changes due to aging. The study identified four overarching themes in singers' appraisal of age-related vocal changes: (1) modest self-perception of their vocal prowess and its relationship to performance, (2) acute sensitivity to changes in vocal quality, (3) recognition of the critical association of voice quality with their identity as a performer, and (4) an array of accommodations to aging-related vocal changes. These transitions are framed from a life course perspective against the backdrop of the demands of a changing music industry, limited access to and use of clinical interventions, high and sometimes unrealistic audience expectations, and differing levels of responsibility of each of these constituencies. There is a need to provide empathy for the changes experienced by aging singers. Supportive intervention that maximizes vocal performance and singer wellbeing is especially needed during the twilight of their career as they continue to share songs that inspire and enrich the lives of audiences.

Component III Primary Objective – Treatment of the Aging Voice

The primary objective of Component III was to examine the efficacy of Vocal Function Exercises (VFEs) in enhancing voice production in adults who present with presbylaryngeus, as compared to an ASP therapy protocol. This project was designed as a pilot study to collect preliminary data on the efficacy of VFEs in the aging voice population to support future research on treatment protocols for the aging singing voice.

Component III Rationale:

Voice disorders are common in the aging population with aging changes that contribute to presbylaryngeus occurring in all the subsystems of the voice producing mechanisms of respiration, phonation, and resonance.[2-4] The exact prevalence of presbylaryngeus is unknown, however is estimated to be between 12 and 30 percent of older adults with a lifetime prevalence for a voice disorder at 47 percent of adults 65 years and older.[5,6] Approximately 29 percent of non-institutionalized adults 65 years and older report a current voice disorder, with 60 percent of that 29 percent reporting a chronic voice disorder (defined as lasting for more than four weeks). [5,7] This group accounts for approximately 27 percent of those seeking specialized care for a voice disorder.[8] Rapid increase in the aging population has significant impact on the public health, social services and health care delivery system.[9] The most recent report by the Center for Disease Control and Prevention (CDC) shows that the United States was spending 66 percent of healthcare dollars on the treatment of chronic conditions in 2013. At this time, in the elderly population, two out of three people had multiple chronic conditions and spending for chronic diseases represented 95% of healthcare dollars spent.[10] This number has, without question, increased as the aging population is growing. As this shift happens, older adults are also working longer and living longer and want to have an improved quality of life as they focus on aging in place. It is practical to focus on addressing presbylaryngeus and help prevent worsening conditions as this population continues to age, from both a financial and health standpoint. The VFEs were chosen as the treatment modality for presbylaryngeus in this study and outcome variables from all five domains of voice assessment (subjective, auditory-perceptual, aerodynamic, acoustic, and visual-perceptual) were collected pre-intervention, post-intervention, and at a one-month follow-up to compare for improvement or possible regression.

Component IV Primary Objective – Crafting the Stage Show Across the Continuum

Elite vocal athletes are challenged by age to sustain their careers. Deterioration of the voice is recognized as part of the normal aging process; however, these changes can significantly threaten or even end a career. The changing music industry has forced aging contemporary commercial music (CCM) singers/performers to return to active concert schedules to maintain income. The purpose of this final study was to determine if and how aging singers are successfully crafting a stage show that is both allowing for accommodations and also pleasing to the audience when they are struggling with the anatomic and physiologic changes that occur in the aging voice producing mechanism.

Component IV Rationale:

To understand the unique experiences of aging CCM elite vocal athletes – what they are experiencing, how they are adjusting, and the success or failure of their continued adaptations. We examined the concerts of six CCM elite vocal athletes at six different points across their performing career. From this analysis we calculated a total percent sang for each concert and averages for early, mid, and late career points. Any observable vocal or performance problems and potential accommodations were recorded and analyzed along with fan reactions that were left as comments to the online concerts. From this analysis we were able to classify the accommodations in to three categories (additions, deletions, and distractions) and assess them against the fan reactions which resulted in four different fan reaction types (those who want change, those who accept the change, those who hate the change, and those who don't care – they just love the singer).

Summary

The intent of this chapter was to provide the reader with a brief overview of the rationale and significance of the four components of this dissertation. Chapter 2 provides a comprehensive review of the literature as it pertains to all four components of this comprehensive study of the aging voice of elite vocal performers.

CHAPTER 2: REVIEW OF THE LITERATURE

This chapter provides an overview of relevant literature on the aging voice and the aging elite vocal athlete. The first section will review literature pertinent to the aging voice and how aging effects the three subsystems of voice production: respiration, phonation, and resonance. The second section briefly compares normal aging with a voice disorder and discusses treatment options for the aging voice. The third section explores current evidence on voice rehabilitation for presbyphonia and/or presbylaryngeus. The fourth section introduces the concept of the elite vocal athlete, the exceptional voice, and a new voice production continuum. Finally, a fifth section raises awareness of performance and vocal challenges elite vocal athletes face as they age. Critical review of this literature leads inexorably toward the questions addressed in this dissertation.

The Aging Voice – An Overview

Voice Producing Mechanisms: Respiration, Phonation, and Resonance

We all grow old. There are few things in life more certain than the gradual, yet predictable changes that happen to the body due to aging.[11] The voice producing mechanism consists of three equally important subsystems, respiration, phonation, and resonance [12,13] [14-24] Efficient voice production requires a relative balance among these subsystems with perturbations of one resulting in compensation of the other two, subsequently disrupting and altering the voice.[25] Aging changes of the larynx (presbylaryngeus) have been well documented and include structural and neurogenic changes.[24,26-36] Such deterioration of voice (presbyphonia) is recognized as a part of the normal aging process, however it can cause significant changes to voice production. The typical person with presbyphonia will present with a complex array of symptoms such as a weak, thin voice with decreased range, pitch instabilities, reduced ability to increase volume, speaking pitch changes, and a muffled quality to their speech.[25] Since the etiology is multifaceted, treatment requires addressing these issues across the various subsystems involved.[37]

The definition of a voice disorder is multifaceted. A voice disorder exists when a person's quality, pitch, and loudness differ from those of similar age, gender, cultural background, and geographic location or when either the structure, the function, or both of the laryngeal mechanism no longer meet the voicing requirement established by the speaker.[25] Presbyphonia can be the result of multiple physiological changes to the three vocal subsystems that ultimately result in perceptual changes to the voice. These changes are noticed by listeners and may be sufficient to negatively affect the listeners' attitude toward the aged speaker and can affect overall quality of life.[38] In addition, the presence or absence of a voice complaint appear to be dependent on the need the person has for their voice. For example, people who use their voices in a professional or vocally demanding environment will be more likely to notice a voice change due to the need for their voice to function at an optimal level.[39] When voice fails to meet daily needs, individuals may recognize a voice disorder. Consequently, by definition, normal aging, while not a disorder, can result in a voice disorder depending on the context of the experience (i.e., person, vocal demands, etc.).

Effects of Aging on the Respiratory System

Respiration

Normal voice production requires the generation of adequate and stable air pressure from the lungs, or the power source for the voice. This is supported by thoracic and abdominal musculature. The lungs are housed in the ribcage and separated from the digestive organs by the diaphragm - the only passive muscle of respiration. During inhalation, the diaphragm contracts; this pulls the lungs downward which expands them and increases the lung volume. During exhalation (for resting breathing), the vocal folds remain abducted as the diaphragm relaxes, the air leaves the lungs, and the lungs return to the expiratory position. During phonation, the vocal folds adduct at midline, which constricts the airstream as it flows upwards. Subglottic pressure increases as the airflow builds up and the vocal folds reach a point where they can no longer withstand the subglottic pressure and are blown apart and set into oscillation, thus creating the vibratory source for voice production.[40]

In efficient phonation, the abdominal muscles are optimally positioned to promote easy diaphragmatic-abdominal respiration, an extension of the normal respiration pattern. In quiet breathing, the inspiratory and expiratory cycles should be mostly equal in time. However, speech (and singing) occur on the expiratory cycle of respiration and require the speaker to lengthen the expiratory cycle and shorten the inspiratory cycle. [41] This becomes a problem when facing aging related changes to the respiratory system. The respiratory system has multiple anatomical, physiological, and immunological changes that affect the total system compliance, potentially causing increased work with breathing (and subsequently, phonation). [42]

Singers use various breathing patterns when singing including diaphragm activation during inhalation, primarily ribcage expansion, or a combination of both. Some singers choose to expand the abdominal wall by contracting it and thus pushing the diaphragm up into the ribcage prior to starting a phrase while another choice is to keep the abdominal wall expanded during the sung phrase, relying on the ribcage contraction to produce subglottal pressure. Still other singers use a combination of contracting both the abdominal wall and ribcage at the same time while singing.[43] While some older singers may notice that they are not able to sing as many words per breath or sustain notes for as long, many older performers who are physically fit may not notice any significant changes to breath support.[44] There are known differences between respiratory function for classical singing vs CCM country music singers. A study by Hoit et al, examined the respiratory function for elite vocal athletes in CCM country music genre and found that the singing respiratory performance of country music singers was more closely related speaking respiratory patterns than the respiratory patterns of classically trained singers. Classical singers typically demand an enormous range of lung, rib cage, and abdomen volumes when singing while the country singers were found to use a smaller abdomen and larger rib cage volume when singing with less lung volumes than the classic singers. This study attributed the differences between the CCM and classical singers due to the often lack of formal singing training for CCM singers compared to the typically highly trained classical singers.[45] Further investigation is needed to determine the respiratory patterns of other genres of CCM elite vocal athletes.

Respiratory Changes

Complex, interrelated changes in the lung and chest wall muscle function and mechanics result in changes in lung volume and ventilatory flow rates.[46] Respiratory function typically decreases with advancing age resulting in a 40% reduction in vital capacity between the ages of 20 and 80 years.[47] Primarily, residual volume increases while vital capacity decreases. This significant change diminishes respiratory potential for speech and/or singing by undermining the power source. Additionally, lungs lose elasticity and the abdominal muscle mass begins to deteriorate. Respiratory muscle strength decreases and can make it harder to build adequate subglottic pressure for cough or increased loudness.[42] Furthermore, there are alterations of the thorax and lung size with a decrease in lung elastic recoil.[48]

Aging also affects the cartilages with calcification of the costal cartilages with infiltration of respiratory skeletal muscles by connective tissue and large lung volume and rib cage excursion. Changes to lung histology and lung-thorax mechanics are non-linear through the aging process. Zeleznik (2003) suggests that there is no evidence that changes in the respiratory system due to aging impact day-to-day functioning of normal, older adults. However, this author acknowledges that these changes may become evident under circumstances when the physiologic demand reaches the limits of supply. From a voice perspective, when we reach those limits, the declines within the respiratory system result in loss of breath control, loss of vocal intensity, and increased amount of lung volume expended per syllable. The speaking rate might also drop from the typical 150 words per minute (wpm) at age 40 to ~125 wpm at age 75.[49] Respiratory changes over the aging process can also reduce maximum phonation time secondary to respiratory dysfunction. These changes to the respiratory system immediately interfere with the efficiency of the vocal mechanism.

Effects of Aging on the Laryngeal Mechanism

Phonation

Hirano played a critical role in helping us understand the delicate layers of the vocal folds through identifying histologic differences in the various areas of the lamina propria and subsequently, relating those findings to vocal fold physiology with clinical implications.[50-52] He discovered that the vocal fold microstructure consists of an epithelial layer, the superficial lamina propria (Reinke's space), the vocal ligament (the intermediate and deep layers of the lamina propria), and the vocalis muscle.[50] Each of these layers have very different and important mechanical properties that are critical to maintaining the functional integrity of the vocal folds.[53] The epithelial layer consists of nonkeratinized stratified squamous epithelium and lies above and below the vocal fold separated from the respiratory epithelium by small areas of transitional columnar epithelium. Not considered one of the five vocal fold layers, the basement membrane zone (BMZ) is a well-defined microcellular transition region that lays under the epithelium and above the superficial layer of the lamina propria. These anchoring fibers are believed to provide a small amount of protection against the mechanical stress caused by vocal fold vibration. The BMZ helps preserve the vocal fold tissue health and aids in the healing after a mechanical trauma and fold shearing.[40,52]

The superficial layer of the lamina propria (SLP) is located directly beneath the epithelium and corresponds to Reinke's space. It is histologically characterized by having loosely interwoven tissue with very few collagenous or elastic fibers. The SLP is responsible for imparting the vibratory characteristics of the true vocal folds. The intermediate layer of the lamina propria (ILP) lies deep to the SLP. It consists of mostly branching elastic fibers with sparse amounts of collagenous fibers. The deep layer of the lamina propria (DLP) is composed of densely packed, collagenous fibers that are gently twisted and formed into bundles that run parallel to the edge of the vocal muscle. These layers, (ILP and DLP) form the vocal ligament, which provides support to the overlying SLP.[51,52,54] The layers increase in stiffness as we travel deep to the vocalis. This final histologic layer forms the main body of the vocal folds and provides mass, stability, and tonicity to the overall structure. It provides additional oscillations during the vocal fold vibration, and due to the innervation, is able to contract and relax to contribute to the overall vocal fold tone and tension. The vocalis is the only part of the vocal folds that is both active and passive in vibration. [55]

Aerodynamic-Myoelastic Theory

The vocal folds are capable of converting a consistent stream of air into vibratory tissue motion to produce an acoustic wave, or self-sustaining oscillation. Van den Berg's aerodynamic-myoelastic theory of vibration states that both aerodynamic (airflow) and myoelastic (muscle) properties account for the passive convergent and divergent motions of the vocal folds during vibration. At the initiation of phonation, subglottal pressure increases below the adducted vocal folds until the vocal folds are unable to withstand the pressure any longer and are blown apart, which causes the airflow to rush through the glottis. When this happens, there is a pressure drop that occurs between the vocal folds since pressure and flow are inversely proportional. This rapid drop of pressure draws the vocal folds back together in accordance to the Bernoulli principle with elastic tissue recoil also pulling the vocal folds back to midline for one complete cycle of vibration. When the folds are once again reapproximated, the subglottic pressure begins to build anew to repeat the process.[55-57] This theory emphasizes the role of subglottal pressure and transglottal flow as they interact with the vocal fold tissue elasticity and resistance. The weakness of this theory is that is does not account for the specific vibratory characteristics of the vocal folds.[58]

Hirano's Body Cover Theory

Initially, according to the mechanical classification, the most superior tissue of the vocal folds was called the cover and the deeper tissue was called the body. [51] The cover is made up of the epithelium and the superficial layer of the lamina propria. The intermediate and deep layers of the lamina propria are called the transition and the body consists of the thyroarytenoid (TA) muscle (vocalis). The TA is a paired skeletal muscle that forms the bulk of the true vocal fold body and brings the vocal folds to midline during phonation thus managing the tension along the vocal fold edge. [59] This is a fatigue resistant muscle which is atypical among human muscles.

The cover appears thicker and extends to include more of the transition for vibration dependent on the needed intensity and pitch of the voice. [60] Hirano's work on the body-cover theory is used to describe the vocal fold structure and states that if the vocal-fold model is for physiological or clinical purposes, then it must have parameters that can be varied to simulate different conditions produced by various laryngeal adjustments or by pathological variations. [50,51] It explains how the vocal folds can be divided into two separate tissue layers that each have different mechanical properties. This theory recognizes the importance of the passive and superficial layers of the vocal folds and their contribution to vocal fold vibration.

The body consists of tightly connected collagen fibers of the vocal ligament and muscle fibers. The cover consists of the epithelium and the superficial layer of the lamina propria and acts as a pliable sheath surrounding the body. The cover is loosely connected to the body during vibration and the motion of the cover is observed as a surface wave that propagates from the bottom of the vocal fold to the top, experiencing movement in both the lateral and vertical directions[61]. This surface wave behavior is highly important for self-sustained vocal fold oscillation with the body layer primarily contributing to the lateral motion. Hirano proposes that the vocal folds should be viewed as a double-structured vibrator where the stiffness parameters should be based on the relative activations of the thyroarytenoid and cricothyroid muscles. The subsequent vibration of the vocal folds is made of the coupled oscillations of both the body and cover layers.[50,51,61] This theory recognizes the importance of passive and superficial layers to the vocal fold vibrations.

Titze's Self-Oscillation Theory

Titze (1994) adds to the previous research on the theories of vocal fold vibration by combining the Bernoulli effect with the influence of respiration and adding in the top-down loading effect. This theory acknowledges that respiration is the driving force to initiate the vocal folds into vibration. The air pressures and airflow interchanges are provided by the pulmonary airstream at the subglottis, glottis, and supraglottis to maintain vocal fold vibration. The leading edge of the vocal fold is set into motion by the subglottal region directly under the vocal folds. There is continuing pressure and flow changes at the intraglottal space between the vocal folds as they vibrate open and closed. Above this, the supraglottal air column is where the air molecules are alternately compressed and rarefied in a delayed response to the alternate pressure and flow changes modulated by the vibrations of the vocal folds. This excitation of the supraglottic air column facilitates the top-down loading effect that helps sustain vocal fold oscillation.[60]

Phonatory Changes

Research on the histologic aspects of the vocal folds show age-related changes to the vocal fold layers that are consistent with the characteristics previously mentioned. The epithelium has alterations in thickness (this may increase or decrease). There is a reduction in vocal fold mucosa thickness [62] and changes in the elastin fibers of the SLP.[22] Normal thickness of the SLP and ILP vary and this affects what layers and how much of the middle layer of the lamina propria are included in the cover. [63] The SLP becomes thicker, more fibrous, less elastic and more edematous in both men and women. At birth, there is a very large cover-to body ratio. As we age, there is a proportional increase in the total width of the ILP and a decrease in the width of the SLP which decreases the amount of cover in relation to the body. [64] The thinning of the superficial layer of the lamina propria may contribute to the formation of a vocal fold sulcus, which is often seen in the senescent larynx where the SLP is atrophied but the ILP and DLP are still relative normal with mild thinning of the ILP as it starts to become more fibrous. This thinning of the layers occurs in conjunction with stiffening as the tissues age and deteriorate with conversion of SLP to MLP. Additionally, the collagenous fibers of the DLP thicken and become fibrotic and less flexible.[65,66]

At the level of the vocalis muscle, the TA experiences planned cell death, or apoptosis, that results in the loss of type I and type II muscle fibers. New muscle fibers are thought to be regenerated in response to the age-related decline of the muscle fibers and apoptosis, although if there is not sufficient nerve supply to the muscle these fibers will continue to atrophy and cause vocal fold bowing. The TA also undergoes increased glycolytic metabolism and increased mitochondrial abnormalities.[67] The mucous glands degrade with advancing age through alterations in the composition and productivity of the glands, which results in less than ideal lubrication of the vocal fold surface and a likely change in the biomechanical properties of the superficial epithelium of the vocal folds.[68,69] The vocal folds become discolored, often grayish or yellowish in appearance.[16,19,24,70,71] This change in the visual appearance is suggestive of changes in the vocal fold tissue structure.

The deterioration of the TA is thought to be one of the primary contributors of presbylaryngeus as the TA is one of the primary muscles of voice production.[18,72,73] As aging changes affect the TA, fat degeneration and atrophy of the muscle occurs.[14,23,24] This loss of muscle mass can change the linear nature of the vocal fold edge interfere and restrict the TA's ability to fully participate in voice production. [67] As the vocal folds atrophy it leads to a prominence of the vocal process, [34] which in combination with the vocal fold atrophy leads to the classic configuration of a spindle shaped glottal closure pattern. Other age-related changes to the vocal fold include a reduction in vascular supply, and a reduction in contractile force, speed, and endurance.[29,74,75]

Looking outside the vocal folds, there is atrophy across all of the intrinsic laryngeal muscles due to overall fewer muscle fibers which are typically thinner and demonstrate degenerative changes.[75] The laryngeal hyaline cartilages calcify and ossify as we age with the process beginning in early adulthood, although it is sooner and more complete for men than for women. As we reach old age, these changes are rather extensive and cause the mechanical properties of the cartilages to be severely altered. They become less yielding, although the articular surface of the joints appear to be spared from calcification.[75]

Some gender differencescome with aging as well. The female voice decreases in fundamental frequency (f_0) with increasing age and this is often attributed to vocal fold edema secondary to postmenopausal changes. Boone suggests that the lowering of f_0 is a result of increased systemic androgen. When the ovaries secrete minimal or no estrogen, but continue to secrete androgen, this can contribute to overall instability with rapid changes of vocal quality along with the lowered f_0.[44] This edema adds a mass effect to the vocal folds and also changes the depth and contour of the folds.[26,76] Estrogen deprivation from menopause causes substantial changes to mucous membranes that line the vocal tract, changes to the muscles and other areas of the body. This decreased hormonal load can be avoided with the use of estrogen replacement therapy but providers must be careful of androgens which can masculinize the voice and cause irreversible changes.[11]

Innervation

There are changes to the function of the nerves that innervate the larynx secondary to aging including myelin abnormalities, a reduction in nerve fiber size, and a reduction in motor end plate size and density. These changes may result in altered sensory and motor function of the larynx. The amount of motor units declines with less efficient nerve connections. In particular, the laryngeal motor neurons take longer to remodel with aging and are required to supply larger muscle area due to the decreased total motor neuron supply.[55]

Acoustic changes

Jitter (cycle-to-cycle variation in fundamental frequency), shimmer (cycle-to-cycle variation in amplitude) and harmonic-to-noise ratio (HNR – additive noise in the vocal signal) are key acoustic values that tell us about the integrity of the vocal mechanism. All three measures are increased in the aging voice. Increased HRN appears to be the most sensitive index of vocal function of the three as it reflects both cycle-to-cycle variability in frequency and amplitude as well as the additive noise generating at the glottis. [77-79]

Effects of Aging on the Resonance System

Resonance

The final subsystem of voice production is resonance. Sound waves powered by the respiratory system and created by the vibration of the vocal folds (the source) resonate through the vocal tract (filter) to produce voice. These waves travel through the supraglottic air column into the pharyngeal, oral, and nasal cavities. The size and shape of the various cavities of the vocal tract will influence the final acoustic output, or our "voice". Changes in shape are created by the articulatory structures: the velum, hard palate, teeth, tongue, and lips. Resonance occurs when sound is reinforced or prolonged as acoustic waves reflect off other surfaces.

Source-Filter Theory and the Tube Resonator Model

Classic speech science literature has presented the source-filter theory and the tube resonator model to account for the relationship between the cross-sectional dimensions of the vocal tract and formant frequencies of the person speaking.[80-84] The vocal tract is seen as a tube resonator starting at the level of the glottis and extending up to end at the lips. This model states that formant frequencies are inversely related to the length of the vocal tract.[80,83] The tube resonator predicts formant frequencies of the vowels, starting with the neutral vowels which do not involve any significant constrictions in the vocal tract. The shape of the vocal tract changes through alterations of the tongue to produce the various vowels. Each vowel has a specific formant pattern. Formant 1 (F1) is associated with tongue height: the high vowels have a low F1 frequency and the low vowels have a high F1 frequency. F2 is associated with the anterior-posterior position of the tongue: back vowels have a low F2 frequency and front vowels have a high F2.[85] Articulatory changes, including lip rounding and lip spreading, impact the formant frequencies of the vowels as well. Lip rounding typically lowers all of the formant frequencies due to a lengthening effect on the vocal tract.[60]

Resonance Changes

Continued craniofacial growth includes increased endocranial dimensions, increased facial dimensions along both bony and soft aspects, tongue atrophy, pharyngeal muscle atrophy and weakening and lower laryngeal position in the neck. Loss of dentition can affect articulation and may cause difficulty with occlusion.[11] These changes in vocal tract size and configuration contribute to alterations in the tract's response to the laryngeal tone through a change in the sound output.

As recently as 1991, Weismer and Liss stated that, at that time, there were no theories of speech production that addressed the effects of aging on the supraglottal system and the formant structure of the speakers. They theorized that this was likely due to a lack of data on the supraglottal articulatory function in the elderly population.[86,87] Several studies speculate on vocal tract changes based on the analysis of formant frequency data and suggest that this is due to either continued vocal tract growth with aging or changing articulatory patterns with age.[86,88,89] Other studies contradict this, reporting that the average F1 frequency levels for the front and mid-vowels were significantly higher for older adults compared to young speakers and the average F1 frequency for back-vowels were significantly lower for older adults. Rastatter and Jaques suggest that this is due to articulatory positioning and not changes in the dimensions of the vocal tract.[90] Linville and Rens (1998) found similarly that F1, F2, and F3 for females and F1 for males lowered significantly across the lifespan.[91] Although these studies talk about acoustic changes to the voice, no measurements were obtained regarding changes to the dimensions of the vocal tract and how this changes with aging. Recently, several researchers have used magnetic resonance imaging (MRI) to attempt to measure vocal tract structure with two-dimensional imaging.[92-95] There is a lack of volumetric (or 3-dimensional) imaging of the vocal tract as it is still very costly to perform, with artifact (signal disruption), and difficulty with directly obtaining volumetric information of the vocal tract morphology.[84]

Currently, acoustic reflection (AR) technology is used to provide an objective assessment of the upper respiratory airway and provide documentation of changes due to aging as seen in the vocal tract dimensions.[84,96] Xue & Hao (2003) found increased oral cavity length and volume in elderly speakers as compared to young with consistent lowering of formant frequencies, in particular, F1, across specific vowels.

Hormonal Changes Affecting Resonance

The endocrine system is also affected by aging and there is a subset of older adults with undiagnosed hypothyroidism. This is because the symptoms of hypothyroidism are similar to aging changes and include mental slowing, decreased energy, neurotic behaviors, dry skin, hearing loss, weight gain, musculoskeletal discomfort, and changes in facial appearance. This alteration in the normal production of the thyroid can decrease vocal efficiency, range, and lead to a "muffling" of the voice. Fortunately, these changes are reversible with appropriate diagnosis and treatment by the appropriate medical professional.[11]

The next section introduces the reader to perceptual changes of the three subsystems of the voice producing mechanism.

Perceptual Changes to the Three Subsystems Due to Aging

Old people sound different; simply put, they sound "old". Untrained listeners can accurately judge age based on pure vocal quality with no visual clues, such as when listening to a phone call or recorded voice memo.[97] What is it about the aged voice that contributes to sounding "old"? What clues are we picking up on to be able to correctly and even easily judge this phenomenon? While physical changes due to aging and vocal symptoms of presbylaryngeus are frequently observed, and well-documented in the literature, the underlying mechanism of the aging voice is not well understood and difficulty to study.[67] Research on the aging voice has consistently revealed age-related changes of pitch, loudness, vocal quality and range. [18,76,87,88,98-100] These perceptual changes are some of the "clues" that identify an "old" voice. Perceptual changes across the respiratory, phonatory, and resonance systems are due to physiological changes to these systems as a result of aging. We now examine each of the subsystems and discuss perceptual changes that affect respiration, phonation, and resonance.

Respiration

Changes to the respiratory system due to aging can be rather severe and are not necessarily reversible. Decreased vital capacity contributes to less than ideal pulmonary reserves which can affect both subglottal pressure and vocal loudness. The greater the amount of air pressure from the lungs, the more tense the vocal folds will be and the louder the sound. The lower the air pressure is from the lungs, the slacker the vocal folds and the softer the voice will be. When there is inadequate pulmonary reserve to start with, it becomes increasingly more difficulty to increase loudness. Decreased ability to get loud, or a "softer" voice is one of the perceptual clues provided by the respiratory system that aging changes are occurring. Another perceptual clue is running out of breath while speaking. Sentences or phrases that may have only needed one breath previously, may now require additional breath which may or may not happen at an ideal time in the phrase. This change in speech breathing is also manifested as a reduced number of syllables per breath. This contributes to a change in the intonation pattern of speech by sounding halting, broken, or irregular rather than smooth and connected.[49]

Phonation

Aging-related changes to the phonatory system are extensive and far-reaching. Vocal fold atrophy, bowing, and other physiologic changes correlate with vocal output symptoms of presbyphonia, or aging voice, increased breathiness, asthenia, decreased volume, and loss of vocal efficiency.[55,101-103] This system provides many of the perceptual clues of aging such as hoarseness and strain. These correlate with the changes in the vocal folds and resulting compensatory supraglottic hyperfunction that accompany the perceptual change of altered pitch (F0). Pitch rises for men (typically after the 5th decade) and drops for females (until around 80 years of age) across the lifespan.[76] Although we measure the acoustic signal of frequency, what we perceptually hear is pitch. Vocal fold atrophy also causes loss of the upper pitch range and loss of vocal flexibility. [98] We hear this in aging singers as a sign of vocal decline. A vocally healthy singing voice is one that has free access to the full vocal range with ease of production. Aging singers would also notice changes in the vocal vibrato, pitch inaccuracies, and possibly the development of a tremolo. Changes in the acoustic signal as represented by jitter, shimmer, and HNR are perceptually experienced as hoarseness in the voice.

Resonance

Changes to the resonance system are reflected by changes to the volume and length of the vocal tract, tongue, lips and oral/nasal cavities. Shifts in resonance are reflected by a change in vocal placement, which is perceptually heard as a back focus, muffled or "damped" vocal quality, decreased loudness (secondary to placement shifts) increased or decreased nasality and a slowed speech rate (potentially due to tongue atrophy and decreased neurological signal).

The next section will begin by examining the difference between normal aging and voice disorders

VOICE DISORDERS VS. NORMAL AGING

Current Trends in Aging

As previously discussed, voice disorders are common in the aging population with aging changes that contribute to presbyphonia occurring in all the subsystems of the voice producing mechanisms of respiration, phonation, and resonance.[2-4] Currently, the population of individuals over the age of 65 years in the United States has expanded from 37.2 million in the year 2006 to 49.2 million in 2016. The number of adults over the age of 64 is projected to be 98 million in 2060 with all of the baby boomers over age 65, comprising one-fifth of the total US population.[104-106]

The exact prevalence of presbylaryngeus is unknown. It is estimated to be between 12 and 30 percent of older adults with a lifetime prevalence for a voice disorder at 47 percent for persons 65 years of age and older.[5,6] Approximately 29 percent of non-institutionalized adults 65 years and older report a current voice disorder, with 60 percent of that 29 percent reporting a chronic voice disorder (defined as lasting for more than four weeks). [5,7] This group accounts for approximately 27 percent of those seeking specialized care for a voice disorder.[8] Rapid increase in the aging population has significant impact on the public health, social services and health care delivery system.[9] The most recent report by the CDC shows that the United States was spending 66 percent of healthcare dollars on the treatment of chronic conditions in 2013. At this time, in the elderly population, two out of three people had multiple chronic conditions and spending for chronic diseases represented 95% of healthcare dollars expenditure.[10] This number has, without question, increased as the aging population is booming. As this shift happens, older adults are also working longer and living longer and want to have an improved quality of life as they focus on aging in place. It is practical, from both a financial and health standpoint, to focus on improving presbylaryngeus and help prevent worsening conditions as this population continues to age.

Voice Disorders

A voice disorder occurs when the vocal folds are unable to vibrate well enough to create a clear vocal signal, or sound.[25] These changes are deviations from a "normal' voice and are permanent. This does not refer to short-term vocal changes that may be secondary to allergies, an upper respiratory infection, or even excessive vocal use at a sporting event. These transient changes may cause vocal problems, although these problems are temporary and, in most cases, voices will quickly return to normal. When changes become chronic, referral to a laryngologist and voice pathologist for a comprehensive voice evaluation is recommended. Although age-related voice changes, or presbylaryngeus, does not necessarily produce a voice disorder, it can lead to the deterioration of voice is recognized as part of the normal aging process. These changes do lead to vocal problems sufficient to significantly alter communication capacity and negatively affect quality of life. As people age, it is accepted that they will have decline and changes to tissue strength and quality as a natural part of aging. Unfortunately, many older adults believe that having difficulty with their voice is an expected and non-negotiable part of aging. Turley and Cohen (2009) and Roy et al. (2007) found that only 15-20% of those suffering with aging voice complaints sought treatment for their dysphonia. Many studies have showed that vocal decline or deterioration in older people has been associated with a wide range of negative impacts on activity, social participation, and psychological well-being, with a large impact on the overall quality of life. [5,107-111]

TREATMENT OPTIONS FOR THE AGING VOICE

Patients with presbylaryngeus have two treatment options for presbyphonia related to vocal fold atrophy: Surgical intervention and behavioral voice therapy.

Surgical Intervention

The most common surgical treatments are injection laryngoplasty and medialization thyroplasty. These are done with either general anesthesia in the operating room or local anesthesia in the otolaryngology office. In-office injection laryngoplasty procedures can be performed before laryngeal changes are severe and may potentially reduce or delay a subsequent medialization thyroplasty.

Injection Laryngoplasty

The goal of the injection laryngoplasty procedure is to improve glottal closure. This is performed by implanting the injectable material deep to the lamina propria with the purpose to medialize the remaining vibratory tissue of the vocal fold.[112] The most common location for the injection is the posterior membranous vocal fold and the mid-membranous vocal fold. Augmentation materials vary from temporary to permanent and include autologous fat, hyaluronic acid-based preparations, collagen, micronized dermis, gelfoam, carvoxymethyl-cellulose, and calcium hydroxylapatite (CaHa).[113-118] Surgeons strive to find a balance between injecting enough of the augmentation material to improve glottic closure while avoiding over-injecting which results in increased vocal fold stiffness and decreased vocal fold vibratory parameters.[113]

Medialization Thyroplasty

For patients with significant glottal incompentence (>3mm), a medialization thyroplasty or Type 1 thyroplasty is recommended. For this laryngeal framework surgery, implants used include silastic, hydroxyapatite, Gore-tex, and titanium. This type of surgery is a permanent alteration of the glottic configuration. The implant, used to medialize the vocal fold, is typically placed using an external cervical incision through a window in the thyroid cartilage lamina.[112] Lesser used surgical treatments include arytenoid adduction and laryngeal reinnervation procedures.

Voice Therapy

The alternative to surgical intervention is behavioral voice therapy. Multiple studies have now demonstrated the efficacy of voice therapy as a behavioral treatment modality for presbyphonia.[109,119-122] We now know that voice therapy is a successful primary treatment modality for presbyphonia and presbylaryngeus. A study by Mau, Jacobson, and Garrett (2010) found an 85% improvement with voice therapy as a primary treatment method for 67 patients over 55 years of age who were diagnosed with primary complaints of hoarseness, vocal fold atrophy, and absence of laryngeal or neurological pathology. They found no effect due to gender or age on voice therapy outcomes. [122]

Current research on patients referred to voice clinics shows that older people constitute between 30 and 37% of all referred patients with a substantial increase in the number of older referred patients over the past 10-20 years. Additionally, in this population, patients who showed greater adherence to the voice therapy protocol had significant improvement after treatment.[109,119,121-123]

Do Nothing

I would be remiss if I failed to acknowledge an alternative treatment option for aging voice, the option of doing nothing. For some people, simply knowing what is going on through relating their symptoms to the age-related changes and knowing that it's not "something worse" is enough. These are not treatment-seeking individuals. They are not concerned with the age-related vocal quality changes. The option to do nothing remains a viable choice as long as there are no other concerns, such as the potential for aspiration.

ASSESSMENT OF THE AGING VOICE

Domains of Voice Assessment

Studies that have investigated changes associated with the aging voice and voice outcomes following implementation of a voice therapy protocol typically use one or more, but usually not all of the recommended components of the voice assessment. This section introduces the reader to the five domains of voice assessment used for Component III of the present dissertation.

Domain 1: Visual-Perceptual

Laryngeal stroboscopy is currently the gold standard used clinically to assess vocal fold vibratory parameters and vocal function. High speed laryngeal imaging, albeit not readily implemented in the clinical setting, provides another method of vocal fold assessment that helps overcome the instrumental limitation of laryngeal stroboscopy.[124] High speed imaging is gaining traction in the research lab as it allows for visualization of vocal fold vibration in real time compared to the simulated slow-motion of videostroboscopy, although both methods do allow for direct visualization of vocal fold vibration, vocal function, and laryngeal structures.[125] Due to the subjective nature of the interpretation of the visual-perceptual exam secondary to the numerous parameters in each exam, there are reliability issues inherent in this approach. These concerns include a lack of standardization of rating parameters; however, there are currently several rating scales that can be used to help guide and provide structure to the interpretation process.[125-129] These scales have not been universally accepted and are lengthy to complete.[130,131] There is limited data regarding reliability of visual-perceptual imaging rating parameters. Intrajudge reliability for overall ratings has been shown to range from 0.31 to 0.97,[126] with interjudge reliability ranging from 0.75 to 0.98.[129] Other reliability concerns include the possibility of examiner bias and no universally accepted standardized clinician training for the procedure.

Domain 2: Auditory-Perceptual

The second domain of voice assessment is auditory-perceptual assessment. This assessment is one of the most widely used "no-tech" methods of voice assessment. It is the clinician's rating of the patient's voice using descriptive parameters. These parameters range from more general (e.g., "the patient presents today with mild dysphonia") to very specific (e.g., the patient presents with mild breathiness, asthenia, vocal strain, and a moderate vocal tremor"). There are multiple assessment options for the auditory-perceptual assessment to ensure consistency across clinicians and provide external validity but only a few have been standardized. The two most often used scales for the auditory-perceptual assessment are the GRBAS (grade, roughness, breathiness, asthenia, strain) scale[132] and the Consensus Auditory-Perceptual Evaluation of Voice (CAPE-V).[133,134] The GRBAS scale is used to rate vocal quality within five auditory-perceptual categories: overall grade (G), roughness (R), breathiness, (B), asthenia (A), and strain (S). These instruments are easy to use and quick for the clinician to score on an ordinal scale (mild, moderate, severe). The GRBAS has been found to be less sensitive than the CAPE-V in the ability to detect subtle changes in vocal quality.[135] Due to this, speech-language pathologists have been recommended to use the CAPE-V to appreciate subtle changes. The CAPE-V (Appendix X) was created to help standardize the auditory-perceptual evaluation and to allow for a more sensitive documentation of auditory-perceptual vocal characteristics. This scale assesses the following auditory-perceptual parameters: (1) overall severity, (2) roughness, (3) breathiness, (4) strain, (5) pitch, and (6) loudness. The CAPE-V is a visual-analog scale utilizing a 100-millimeter line. The clinician scores the voice by marking the scale where they feel the voice falls. There are three further parameters to each category scale: mildly deviant (MI), moderately deviant (MO), and severely deviant (SE). The use of the visual analog scale has been attributed to the increased sensitivity of the CAPE-V compared to the GRBAS[133,134,136] and there is a slight increase in rater reliability of the CAPE-V over the GRBAS.[135] The CAPE-V has demonstrated both intra- and interrater reliability and criterion validity. Intrarater reliability using Pearson's r was from .35 to .82 (dependent on voice parameter measured).[133] Breathiness was found to have the highest reliability and strain was found to have the lowest reliability. The Shout-Fleiss intraclass correlation coefficients (ICC) was used to measure interrater reliability which ranged from .28 to .76. Here, overall severity was found to have the highest reliability and pitch was found to have the lowest reliability.[137] Intrarater reliability using Pearson's r resulted in the following: overall severity .57, roughness, .77, breathiness, .82, strain .35, loudness, .78, and pitch .64. Shout-Fleiss intraclass correlation coefficients were used for interrater reliability and are as follows: overall severity .76, roughness, .62, breathiness .60, strain .56, loudness .54, and pitch .28.[137]

Domain 3: Patient Subjective Ratings

The impact that a voice disorder can have on a person's quality of life[138] is not something that can be measured through any other domains of voice assessment. This is measured through patient self-assessment rating scales for voice disorders. Franic, Bramlett, and Bothe (2005) found the Voice Handicap Index (VHI) and the Voice-Related Quality of Life (V-RQOL) to be psychometrically the strongest of available measures.[139] The VHI and the V-RQOL have been demonstrated to be highly correlated.[140] The Voice-Related Quality of Life scale[141] is a short (10 item) questionnaire that examines the patients perception of their voice in the physical and socio-emotional categories. The V-RQOL has high internal consistency with a Cronbach's alpha of 0.89.[141] The VHI is a psycho-social measure of the impact of a voicing disorder on quality of life.[142] This is shown to have strong test/retest reliability and construct validity and be sensitive to a wide array of voice disorders. The VHI is a self-administered questionnaire of 30 questions in which the participant rates the appropriateness of each item (0 = none, 4 = always). The VHI is scored 0-120 with 0 being no perceived disability and 120 being maximum perceived disability. Criterion validity was established and test re-test reliability was as follows: Functional (r = 0.86), Emotional (r = 0.92) and Physical (r = 0.86). These categories are added together to get the total score. A minimal detectable change of 18 points in the total score indicates a clinically significant change in pre and post therapy measures.[142] The VHI was used in the second study of this dissertation.

Domain 4: Acoustic Analysis

Acoustic analysis of vocal quality provides an objective analysis of voice production through indirectly measuring the resonant properties of the vocal tract. While there are numerous acoustic measures, this section will focus on the measures utilized as acoustic outcome measures in component two. Although it is known that frequency and intensity-based measures have limitations regarding their ability to accurately track the fundamental frequency (f_0) in voice production, they are regularly used as outcome measure for research studies as they can be used to compare pre and post-therapy voice changes. One way to balance this limitation is to use a cepstral analysis of voice, such as the Analysis of Dysphonia in Speech and Voice, ADSV, which can analyze a voice with f_0 instability. For this study, frequently used perturbation measures (jitter, shimmer, HRN) were used to analyze sustained /a/ and cepstral analysis was used on both connection speech and sustained/a/. Jitter is the measure of cycle-to-cycle variation in frequency and shimmer is the cycle-to-cycle measure of variation in amplitude. Both jitter and shimmer are reliable for sustained vowels but not for severely dysphonic voices or with connected speech. Both perturbation measures fail to demonstrate strong reliability due to decreased vocal signal in severely dysphonic voices and the difference in extraction methods across various systems.[143] The ADSV and Cepstral Speech Index of Dysphonia (CSID) can be used on severely dysphonic or aperiodic voice for sustained vowels and for connected speech (Rainbow Passage, All Voiced sentence, Hard Glottal Attack sentence, Easy Onset sentence, and Voiceless Plosive sentence)[144] Research by Awan, et al. found that analysis of severely dysphonia voices could be obtained by using a model which incorporated spectral/cepstral measures. He also found a strong relationship between using the CAPE-V (auditory-perceptual rating scale) and acoustic estimates of dysphonia through cepstral analysis.[144]

Fundamental frequency (f_0) is the rate of vocal fold vibrations and is expressed in cycles per second (cps) or Hertz (Hz). The perceptual correlate of f_0 is pitch. Mean f_0 is taken from connected speech (the rainbow passage) and sustained vowels (/a/). Pitch range or f_0 range is a representation of the highest and lowest pitch the patient can produce. Decreased upper range is often a complaint of patients with presbyphonia.

Maximum phonation time (MPT) is collected from a sustained vowel /a/ after taking a deep breath and holding out the vowel for as long as possible.

Domain 5: Aerodynamic Analysis

Subglottic pressure and transglottal airflow indirectly assess the laryngeal valving mechanism and vocal function. Aerodynamic analysis measures the air flow, pressures, and rate of the laryngeal mechanism. These measurements can provide information on the efficiency of laryngeal valving through objective values that are clinically useful and reflective of the current state of the system (i.e., normal to disordered).[145] The aerodynamic measures for component three of this dissertation included phonation threshold pressure, forced expiratory volume, mean airflow rate, subglottic pressure, and laryngeal airway resistance. A brief description of these measures is provided here. Phonation threshold pressure (PTP) is the minimum subglottal pressure needed to initial vocal fold vibration. It can also be used as an indirect measure of phonatory or vocal effort. Subglottic air pressure (Ps) is a measurement of the force beneath the adducted vocal folds. Ps is measured indirectly using intraoral pressure during repeated productions of unvoiced /p/ and the vowel syllable /i/. Laryngeal airway resistance (LAR) is the quotient of peak intraoral pressure divided by the peak flow rate. It is an estimate of laryngeal valving and is intended to reflect the overall resistance of the glottis. Increased LAR is suggestive of supraglottic hyperfunction and decreased LAR is suggestive of hypofunction. Vital capacity (VC) is a measure of pulmonary function. It is the volume of air that can be exhaled from the lungs after taking a deep breath while breathing normally. This measure is used to calculate the goal time for Vocal Function Exercises.

Finally, mean airflow rate (MFR) is a measurement of the average airflow passing through the glottis per second (ml/s). It is measured during phonation over a comfortable or habitual pitch and loudness level and can provide information on the degree of glottal incompetence.

EFFECTS OF VOICE THEARPY ON THE AGING VOICE

Voice Therapy Approach Overview

The Role of Voice Therapy

Older people have less natural reserve and physical resilience than younger people. They can't compensate or tolerate weakness like they did when they were younger. They also can't recover as quickly from injuries to the voice.[6,11,146] Due to this, it is even more important as we age to be in optimal physical and vocal shape. Although the decline of structure and function gradually increases with age, it appears that the decline is not necessarily linear. Humans can possibly maintain, or even reverse biological aging changes to certain structures and influence their impact in our later years.[11,67] Numerous researchers have studied various ways to delay the process or reduce the effects of aging on the voice. Behavioral therapy is designed to strengthen the voice and help reverse some of the aging changes while subsequently restoring normal vocal quality and with maintenance, avoid further decline.[67]

Voice Therapy Approaches

There are five approaches to voice therapy: symptomatic, hygienic, psychogenic, physiologic, and eclectic.[147,148] The following section describes each of these approaches in more detail.

Hygienic

The hygienic approach focuses on finding and modifying and/or eliminating the behavioral cause of the problem to improve the vocal condition and quality. This approach is based on the belief that some functional voice disorders are due to and maintained by behaviors that are phonotraumatic, affecting both structure and function. A hygienic voice therapy approach believes that eliminating vocally abusive behaviors will result in improved voice production.[147] Clinically, hygienic voice therapy is often used as a first step in managing voice disorders and can be very effective when used with other voice therapy techniques.[149-151] Studies have shown that while hygienic voice therapy is better than no treatment at all[151,152] it is less effective in the management of voice disorders compared to a physiologic voice therapy approach such as Resonant Voice Therapy or Vocal Function Exercises[149,153,154] This may be because vocal hygiene is an indirect method of voice therapy – it affects voice production by improving behaviors around voice production rather than directly impacting vocal physiology.[152,154]

Symptomatic

Symptomatic voice therapy focuses on improvement through modification of undesired vocal symptoms such as loudness or hard glottal attacks. This therapy method is thought of as a direct voice therapy method in comparison to vocal hygiene.[155] The method was first organized by Daniel Boone in 1971 and is based on the belief that voice disorders are caused by a functional misuse or abuse of respiration, pitch, and loudness.[156,157] This approach uses multiple facilitation techniques that are selected to target a reduction or complete elimination of the inappropriate vocal symptom improving voice production.

Psychogenic

Psychogenic voice therapy focuses on the emotional and psychosocial status of the patient that led to the development and maintenance of the voice disorder. It assumes that emotional or psychosocial issues are the reason for the voice disorder and that treatment should include referrals to appropriate professionals.

Physiologic

Physiologic voice therapy was first organized and promoted by Colton and Casper (1990) in their text, *Understanding Voice Problems: A Physiologic Perspective for Diagnosis and Treatment* and Stemple, Glaze, and Gerdeman (1993) in *Clinical Voice Pathology: Theory and Management*.[40,150] The physiologic approach currently has the strongest evidence base[158] and concentrates on the modification of the underlying physiology of the voice producing mechanisms of respiration, phonation, and resonance through improving the balance between respiratory support, laryngeal muscle strength, control, and stamina, and supraglottic modification of the laryngeal tone. This approach also focuses on improving the health of the vocal fold cover.[148] It utilizes specific techniques designed to directly alter and modify the physiology of the vocal mechanism. As previously stated, normal voice production requires a balance between respiration, phonation, and resonance. When this balance is disrupted, the end result is often a voice disorder that is due to compensation of the vocal mechanism in an attempt to maintain the balance. The overall goal of physiologic voice therapy is to rebalance the laryngeal subsystems, strengthen the voice producing mechanism, and maintain the health of the vocal fold cover.[2,25]

Multiple therapy approaches use the physiologic approach including semi-occluded vocal tract (SOVT) exercises, Lee Silverman Voice Therapy (LSVT), and Phonation Resistance Exercises (PhoRTE) and Vocal Function Exercises (VFEs).

Semi-Occluded Vocal Tract (SOVT) Exercises

Semi-occluded vocal tract (SOVT) postures are numerous and include straw phonation, tube phonation, lip trills, tongue trills, y-buzz, hand over mouth, voice bilabial fricatives, and nasal consonants.[159] The goal of SOVT exercises is to train source-filter interaction in an efficient and time-effective manner. These SOVT postures are used in evidence-based voice therapy techniques including VFEs, Resonant Voice Therapy, Phonation Resistance Training Exercises (PhoRTE), and the Accent Method.

A SOVT posture introduces some type of narrowing somewhere along the supraglottic point of the vocal tract. Research on the SOVT posture suggests that it heightens the interaction between the glottic source and the supraglottic tract. When the vocal tract is partially occluded, air pressures both above and between the vocal folds increase and maintain the approximated vocal folds in a slightly separated position. This allows the vocal folds to work more efficiently and effectively with the vocal tract, improving vocal economy. When they are performed effectively, SOVT's work to maximize the interaction between the source and filter, resulting in increased vocal intensity, efficiency, and economy.[160]

SOVT exercises are best introduced by starting with exercises that use a greater degree of occlusion (1 = most artificial) to a lesser degree of occlusion (11 = most speech like):

1. Smaller diameter straw
2. Larger diameter straw
3. Tubes
4. Cups
5. Standing waves
6. Bilabial or labiodental voiced fricative
7. Lip or tongue trill
8. Nasal consonants
9. Closed vowels /u/ or /i/
10. Open vowels
11. Speech

Changes in the tube diameter result in different pressure-flow relationships. Submerging the tube in water vs. air, coupled with the depth of the water used and even the angle of the straw also changes the pressure-flow relationship. Resonance and silicone tubes submerged in water, once air flow has started, results in only small changes in P_{back} (static back pressure). Additionally, changes in the tube diameter affect P_{back} more significantly than a change in the length of the tube. Therefore, using a smaller vs larger diameter straw will provide a relatively large change to P_{back} when the flow changes. The differences in the pressure-flow relationship should be used advantageously during therapy to customize the exercises for the patient's needs to optimize therapeutic potential.[160,161]

One of the benefits of SOVT's is that there are multiple ways to perform them, and they can be easily modified and adapted to meet the needs and abilities of different patients. Another benefit, specifically for the presbylaryngeus patient population, is that this type of economy-oriented voice training reduces the potential for vocal injury, which is reduced if vibration dose and collision stress in the vocal folds are reduced.[162]

Lee Silverman Voice Treatment (LSTVT)

Lee Silverman Voice Treatment is a well research voice therapy approach originally designed to be used with patients who have Parkinson's Disease. They are currently supported with three randomized control trials proving treatment efficacy.[163-165] LSVT LOUD utilizes high effort (self-perceived effort) phonation with intensive training requirements (sixteen 60 minutes sessions – four days a week for four weeks) based on the principles of motor learning, skill acquisition, and neural plasticity.[166] LSVT consists of the following three exercises.

(1) Sustained /a/ with improved loudness for as long as possible

(2) Sustained /a/ while increasing and decreasing pitch

(3) Repeating a list of 10 self-selected functional phrases using improved loudness

The second half of the session focuses on a speech hierarchy designed to carry over the improved loudness into functional communication. LSVT LOUD has also been found effective for individuals with stroke, multiple sclerosis, ataxic dysarthria, children with Down syndrome, cerebral palsy, and presbylaryngeous.[166-168]

Phonation Resistance Training Exercises (PhoRTE)

Phonation Resistance Training Exercises (PhoRTE) have their foundation in LSVT, exercise physiology science, voice science, progressive resistance training for limb skeletal muscle atrophy, and motor learning.[166] *Forte,* in Italian, means loud and strong and is a key component of this therapy. This method consists of high intensity exercises that target decreased vocal loudness and increased vocal effort often associated with presbyphonia. PhoRTE is a set of the following five exercises.

(1) Strong energized maximum sustained phonation on /a/

(2) Strong energized ascending and descending pitch glides over the entire pitch range on /a/

(3) Production of patient-specific functional phrases using a strong "calling' voice

(4) Production of phrases from exercise 3 in a voice of "authority"

(5) Strong energized voice production during an extended period of speaking

The patient completes the exercises while maintaining a target sound pressure level (SPL) that is calculated to be 50 to 60% of their vocal intensity range. The exercises are designed to be done once daily using a sound level meter to monitor appropriate loudness during home practice.[119]

Vocal Function Exercises (VFEs)

Vocal Function Exercises (VFEs) are a type of physiologic voice therapy comprising a series of voice manipulations designed to strengthen and balance the laryngeal muscles leading to an enhanced relationship of respiration, phonation, and resonance, thus improving vocal efficiency and voice quality.[169] The intent is to help improve glottic closure and rebalance the vocal mechanism.

Vocal Function Exercises consist of the following four exercises that are performed twice daily (morning and evening) with two trials each.

Exercise 1: *Resonance warm-up exercise* – sustain the vowel /i/ as long as possible

- Females on musical note F4, Males on F3
- This is to be performed with extreme forward focus; "almost, but not quite nasal"

Goal: Sustained /i/ equal to vital capacity/80mL/s (physiologic goal)

The maximum phonation time (MPT) goal for VFEs is based on a calculation that assumes that efficient voice production has a flow rate of 80-200 liters/second. An airflow rate below 80 lit/sec would be limited airflow through the system and a rate above 200 lit/sec would be excessive airflow through the system. (vital capacity/80mL/s = physiologic MPT goal of XX). For a patient with presbylaryngeus who is not a singer, we would consider meeting 80% of this goal sufficient for meeting vocal demands in all areas of daily life (MPT goal of XX *.80 = therapy discharge goal).

Exercise 2: *Ascending Glide* – stretching exercise – glide upward from lowest to highest note on the word “knoll”

- Extreme forward placement, open pharynx, and sympathetic lip vibration (“buzz”)
- Continue the stretch even after phonation has stopped

Goal: No voice breaks

Exercise 3: *Descending Glide* – contracting exercise – glide downward from highest to lowest note on the word “knoll:

- Open pharynx, slow, no growl at the bottom, no muscling of the tone

Goal: No voice breaks

Exercise 4: *Low-impact Adductory Power Exercise* – sustain the musical notes C-D-E-F-G for as long as possible on the word “knoll” without the “kn”

- Females on musical note C4, Males on C3
- Open pharynx, lip vibration (“buzz”)

Goal: Sustained /i/ equal to vital capacity/80mL/s (physiologic goal)

All exercises are performed with a forward tone focus and a decreased loudness level. This helps ensure that the exercises are being completed with vocal technique that minimizes further injury and maximizes laryngeal benefit.

Currently, there are 30 research papers using Vocal Function Exercises as a treatment outcome in multiple populations.[109,119,120,149,153,159,169-193] These studies have demonstrated

VFEs to be effective in enhancing both normal and pathological voices. In the disordered voice population, VFEs have been found to rebalance laryngeal musculature, improving both hyper- and hypofunction and have been used in combination with other treatment approaches to maximum patient outcomes. Eight studies have examined the efficacy of VFEs with the presbylaryngeus population.[109,119,172,174,182,185,187,194] These studies found statistically significant improvements in physiologic measures on all five domains of the voice assessment (patient subjective, acoustic, aerodynamic, audio-perceptual, visual-perceptual). This provides evidence that suggests that VFEs can be used as a behavioral intervention to successfully treat presbylaryngeus, or age-related vocal fold atrophy and presbyphonia.

Eclectic

Finally, the eclectic approach to voice therapy uses a combination of any and all of the previous four approaches with a goal to specialize the treatment targets to the particular needs of the patient resulting in positive vocal change.[148] Eclectic voice therapy is a comprehensive approach that incorporates many of the previously mentioned elements and categories of voice therapy. Using a specifically designed combination of voice therapy approaches can target the specific needs of the patients and follow the new trend in healthcare toward precision medicine.

The next section introduces the reader to the concept of the professional voice user and the elite vocal athlete.

ELITE VOCAL ATHLETES

An athlete is defined by the Merriam-Webster dictionary as: "a person who is trained or skilled in exercises, sports, or games requiring physical strength, agility, or stamina."[195] Elite athletes – those who perform at the national or international level – train with a focus on the exercise physiology principles of intensity, frequency, overload, specificity, and reversibility to maximize their function, endurance, strength, and stamina. The goal is to train muscle memory for a given task to be performed at optimal levels of execution. This skill must not only be highly refined, precise, but also painstakingly consistent. Similarly, individuals who use their voice under these same conditions can be defined as vocal athletes – a person who is trained or skilled in vocal abilities and performance requiring physical strength, agility, or stamina. The very nature of their job also demands precision, control, consistency, and repeatability.

In 1991, Wilder defined professional voice users as "individuals who use voice extensively for some form of artistic expression".[196] This definition is broad and includes professional singers and actors, those seeking to become professional, and skilled amateur performers. Vilkman (1996) defined the professional voice user as "an individual who's profession, either wholly or partially, depends on the use of voice".[197] Wellens and van Opstal, in 1998, proposed two different types of professional voice users: (1) professions with high short- and long-term vocal loading such as coaches and lawyers who typically have had no adequate training in voice, therefore increasing their risk of developing a voice problem and (2) professions with high artistic and esthetic demands such as singers and actors. In 1999, Koufman and Isaacson, defined elite vocal performers – Level 1, as performers who require maximum vocal performance at all times and need superior quality, pitch, range, and loudness. Professional voice users were classified as Level 2; people whose voice is an integral part of their job, such as lecturers, teachers, telemarketers, or group fitness instructors. They need vocal stamina as they require their voice for prolonged periods of time and have a high level of vocal loading as a requirement of their occupation.[198-202] This division of Level 1 and Level 2 performers was needed to differentiate between levels of professional voice users. Further differentiation is still needed to account for the vocal sophistication, vocal quality, and vocal load of high-level performers when compared to trained or avocational singers. The term *vocal athlete* has been defined by Loucks, Duff, Wong, and Finley-Detweiler (1998) as singers "whose livelihood and identity depend on optimal vocal function". They continue by explaining that, "vocal athletes are individuals who train their voices for optimal and consistent function and incremental control over a wide pitch and loudness range". Included in this grouping are classically trained singers and those who have trained their voices to maintain consistent phonatory function.[203]

Professional and elite vocal performers encounter special voice problems not faced by the average voice user. This population must have optimal vocal function at any given time, despite unusually high vocal demands required by their vocation. Therefore, this population is at greater risk of voice problems with more severe negative consequences than for the general population. Even a small change in vocal quality can limit performance ability and this can be devastating to a professional voice career. Often these changes are not perceptible in the speaking voice and can lead to improper diagnosis and delays in treatment. Unfortunately, under the current definition of a voice disorder, subtle vocal changes in elite vocal athletes may not qualify for clinical rehabilitation (and possibly health insurance coverage). There is a need to further refine the definition of the voice of the elite vocal athletes to help address the vocal needs of this elite population. The next section will identify some of the unique demands of aging elite vocal athletes and how these aging changes can affect their performance and vocal output.

Aging Elite Vocal Athletes

As aging elite vocal athletes continue to perform they often begin to realize that their most precious instrument, their larynx, that had previously withstood years of constant use and abuse, has begun to lose the agility and power of their youth. This inexorable process plays out in singers who are determined to continue performing long past their youthful prime. There appears to be a trade-off between vocal agility and age. Singers often refuse to retire; there is still a demand for their concerts, but the price of this vocal longevity is often steep. When the singers have to make accommodations for age-related vocal changes such as decreased upper range or loss of vocal quality, their audience reaction is not always positive. Often, the reaction to accommodations for aging vocal changes is condescension and scorn. Singers' careers often start later in life (in their second decade) and their technical and performance skillsets are often just at their peak when their voices begin to be eroded by time.

Challenges of Aging as a Rock Star

The lifetime prevalence of a person experiencing a voice problem is around 20% with around 7% of people who report experiencing a current voice problem.[204] For singers, this increases to a prevalence rate of 22% for singing students, 55% for singing teachers, 41% for classical singers, and 47% for non-classical or CCM singers.[205] There is currently no research on the prevalence rate of vocal problems for elite vocal athletes or aging elite vocal athletes.

Elite vocal athletes are performers who are required work at their optimal, or peak, levels all the time. The very nature of their job puts them at an increased risk for vocal injury;[25,206,207] as even the subtlest change to certain characteristics of their voice could threaten, damage, or even end their careers. Their livelihood and that of their crew, management team, and all the other personnel included in their circle are adversely affected if they have to cancel even a single concert. This can even include the hotels, restaurants, and business in the locations where the venue is located. Performers who cancel at higher than normal rates are at risk of losing their concert insurance coverage and having to absorb the effects of the cancelled concerts. Dealing with age-related vocal and performance changes can have serious, long-reaching impact on their careers and create significant challenges for these aging elite vocal athletes and those who depend on their performance.

Performance

Changes to performance include physical changes to strength, stamina, agility, and flexibility. Movements are usually less quick and less flashy. There is often a new humbleness in their step and slight hesitation to their execution. Choreography that used to be easy becomes increasingly difficult. Performing is a very physical activity and muscles lose strength and agility as they age. Continued use helps keep the body in shape, but increased effort is required to maintain the previous level of activity. This is added stress to performers who already have a high level of emotional strain and anxiety. Most elite vocal athletes already deal with the stress of worrying about their image, reputation, and ability to meet expectations.

Vocal

Aging elite vocal athletes experience changes in vocal quality such as decreased upper range, decreased loudness, pitch instability, and anatomical changes to the laryngeal mechanism. Any of these changes can lead to the need to use compensatory vocal behaviors, often at the cost of increased vocal effort. They experience these changes in the face of the past as they usually are still performing songs that were written for their voice as a younger performer without vocal problems. These singers have their identity indistinguishably intertwined with their voice; losing their voice is, in a sense, losing themselves. They must learn how to care for what they previously took for granted. The prospect of this task can seem daunting for a performer at this stage in their life.

As their star trajectory begins to wind down at the twilight of their career, singers have to make accommodations to these changes. But what are they doing and how are they changing? Are these changes working? How do they remain vocally relevant?

These are some of the questions raised during my literature review of aging elite vocal athletes.

SUMMARY

This literature review reveals a gap in research on vocal and performance changes of elite vocal athletes that is significant. This leads us to the following overall questions and research needs:

1. The need to define the exceptional voice and propose an expansion of the current vocal production continuum to include high level vocal performers.
2. The need to identify singers' perceptions of their age-related vocal and performance changes.
3. The need to assess the degree to which voice therapy is efficacious for treating presbyphonia?
4. The need to identify how age-related and performance changes affect CCM male elite vocal athletes and explore how they adjust their performance to accommodate these changes?

In the chapters that follow, I examine these questions with four separate approaches: a commentary on the exceptional voice, a qualitative study of singers perceptions of age-related vocal and performance changes, a randomized control trial examining voice therapy as a treatment modality for presbyphonia, and a mixed methods study assessing the age-related vocal and performance changes affecting aging singers and how they are adjusting and accommodating their performances to these changes. These four parts are overlapping and intertwined. They lead us to a deep understanding of the aging elite vocal athlete.

In the next chapter I look at the clinical implications of the current definitions of the elite vocal athlete and the professional voice and explain how the current classification system is often failing professional singers when they are faced with vocal problems.

CHAPTER 3: IN SUPPORT OF THE EXCEPTIONAL VOICE

Chapter 3 presents the viewpoint manuscript, In Support of the Exceptional Voice in detail. This stage of the dissertation helped in identifying a problem that singers seeking voice rehabilitation treatment often encounter. The paper suggests that the current definition of a voice disorder does not provide an adequate description of the voice problems of elite vocal athletes. Under the current definition, the vocal changes that singers are experiencing may not qualify for rehabilitation (and possible insurance coverage). Additionally, the clinical system fails to meet the needs of the exceptional voice because even a subtle decline in vocal quality may affect performance. To address this issue, this article was developed to offer a definition of the exceptional voice, propose expansion of the current voice production continuum to include high level vocal performers, and provide recommendations for the rehabilitation and habilitation of the exceptional voice.

Sloggy,J., Stemple, J., Rowles, G., & Andreatta, R. (2019). In Support of the Exceptional Voice. ***AHSA Perspectives, SIG 3.*** **In Press.**

ABSTRACT

Purpose: The human voice is an exceptionally versatile instrument capable of complex communicative and emotive behaviors. Typically, these behaviors are sufficient for daily communication activities, however elite vocal athletes have higher vocal demands and arguably, enhanced vocal capabilities. The current definition of a voice disorder is a change in quality, pitch, and loudness of the voice that draws attention to the speaker. In this article, we suggest that this definition does not provide an adequate description of voice problems of elite vocal athletes.

Conclusion: As a result, the current clinical system of evaluation and intervention may fail to meet the needs of the exceptional voice when even a subtle decline in vocal quality may affect performance. Under the current definition of a voice disorder, these vocal changes may not qualify for vocal rehabilitation supported by third party payers. To address this issue, we offer a definition of the exceptional voice, propose expansion of the current voice production continuum to include high level vocal performers, and provide recommendations for the rehabilitation and habilitation of the exceptional voice.

Keywords: elite vocal athletes, exceptional voice, voice production continuum, return to perform

Introduction

Among all vocalizing mammalian species, the human vocal tract is an amazingly unique voice-producing mechanism. For communication purposes, it permits us to express the intent, meaning, and mood of the spoken word, to converse and exchange information and ideas, and to express our needs, desires and intimacies, in ways that are vital to effective personal human interaction. Beyond speech, voice allows us to create a variety of sounds associated with emotions such as crying, sighing, and laughter, and sounds associated with our general health such as coughing, throat clearing, yawning, and groaning. For most people, these forms of vocalization meet daily needs, but for some, more is required from their voices to satisfy their livelihoods. These individuals, as a broad group, are considered occupational voice users or professional voice users – people who use their voice professionally such as telemarketers, teachers, coaches, preachers, trial lawyers, or public speakers who rely on their voices to do their jobs. High vocal loading is a requirement of their occupation.[199-202] For these people, losing their voice or even experiencing moderate dysphonia can cause significant challenges and may become career threatening. Wellens and van Opstal (1998) in *Occupational Voice – Care and Cure* propose two different types of professional voice users: (1) professions with high short- and long-term loading such as coaches and lawyers who usually have had no adequate training in voice, thus increasing their risk of developing a voice problem and (2) professions with high artistic and esthetic demands such as singers and actors. This group has also been called elite vocal professionals - a highly specialized sub-category of voice users who place the highest demands on their vocal mechanisms [208]. By the very nature of their job, this population is also at an increased risk for vocal injury [25,206,207]; even the subtlest change to certain characteristics of voice could threaten, damage, or even end their careers.

Our current clinical model of voice production represents voice on a linear continuum from disordered to normal. We suggest that this model is problematic for elite vocal athletes and fails to capture the unique performance realities of this population. A voice disorder occurs when laryngeal mechanism is unable to create a clear vocal signal or sound and is typically defined as quality, pitch, and loudness changes that draw attention to the speaker.[25] A voice disorder requires a deviation from "normal" voice quality. These changes are chronic and different from short-term vocal changes that may occur due to allergies, an upper respiratory infection or excessive vocal use at a concert or sporting event.[156] While these vocal characteristics may be normal in the speaking voice of the elite vocal performer, subtle vocal changes in voice production may affect performance, but often do not rise to a clinical level sufficient to qualify these professionals for voice rehabilitation services.[209] Indeed, without diagnosis of laryngeal pathology, voice rehabilitation services for this population are often denied. To begin addressing this disparity, this article defines and describes the *exceptional* voice and proposes an expansion of the current voice production continuum to include high level performers. Within this expanded rubric, we consider recommendations for the rehabilitation and habilitation of this unique voice population.

Voice Production

Normal voice is understood to require a relative balanced interaction among the three subsystems of voice production: respiration, phonation, and resonance. The relative and efficient balance of these subsystems is critical to maintain vocal efficiency and ease of production. Due to their interdependent nature, a disturbance to any one of the subsystems will often result in some form of compensation from the other two and subsequently a physiologic and performance imbalance. This imbalance can disrupt the efficiency of the vocal mechanism and may lead to a voice disorder.[25]

The Exceptional Voice

Contrary to what might be imagined, the exceptional singing or acting voice is not necessarily a voice of superior aesthetic quality as might be assessed from the perspective of a classical mind set. Different genres of music (i.e., opera verses pop) have different criteria for assessing vocal excellence. For example, it is highly unlikely that Willie Nelson would meet the performance criteria of a male operatic performer or that Placido Domingo's vocal quality would meet the expectations of a typical contemporary music audience. Their training is very different – for Placido, formal technical training versus Willie's simply honed technique that come with performance experience. Yet, there is inherent aesthetic beauty in both of these voices. Although the styles are very different, both types of singers possess unique vocal characteristics that differentiate their voices from those of the general population. The same can be said of the voices of actors. James Earl Jones and Johnny Depp have undeniably different voices, yet both are equally successful in bringing characters to life by giving their voice to the text. These vocalists all have undeniably different sounding voices, yet are equally successful in using different vocal styles, characteristics, and nuances that contribute to the distinctiveness and effectiveness of their ultimate delivery. But, what are the common traits that make a voice exceptional?

Elite Vocal Athletes

Elite physical athletes are "persons trained or skilled in sports or games requiring physical strength, agility, or stamina" [195]. They are unquestionably high-level performers. They have an innate and/or highly trained capacity for their particular sport and have experienced a rise to an elite level through a combination of personal awareness and drive, mentoring by coaches, and serendipitous events that allowed others to see their potential and further their opportunities as a player. These athletes have learned to combine talent for their sport with complementary skills that they have cohesively built and fine-tuned to facilitate performing at an optimal level.

This same definition can apply to the elite vocal athlete: "persons trained or skilled in vocal performance requiring vocal strength, agility, and stamina". Elite vocal athletes are performers working at the top of their craft. Their livelihood, and the livelihoods of many that work for them, depend on an ability to consistently perform at the highest level. If they are not able to perform, cancelling a single show can have an economic impact that stretches far beyond the singer to include their entourage, businesses in the town where they are scheduled to perform, the audience, their insurers, venues, vendors and many other constituencies. Multiple cancellations can make a singer or actor a higher risk from an insurance standpoint and could even lead to dropped insurance coverage. Elite vocal athletes are highly aware of the stakes and everyone who is relying on them to be able to perform their job consistently and well.[25, 210]

Definition of the Exceptional Voice

A clinically accepted definition of the exceptional voice is critical when we consider how to best provide care for the exceptional voice when it becomes injured. Therefore, we suggest that *the exceptional voice is one that is highly trained to the demands of a particular aesthetic and that possesses unique vocal characteristics and abilities that differentiate that voice from those of the general population.*

The Voice Production Continuum

The clinical voice world has long conceived of the voice on a linear continuum of disordered to normal (Figure 3.1).

Figure 3.1 – Current Voice Production Continuum

We know that every voice is unique, yet there are accepted criteria used to judge normal versus disordered voices as previously described. When a voice no longer meets these criteria, it is considered disordered with the goal of vocal rehabilitation to return the person's voice to as close to "normal" as possible.[25] But what is normal and more critically, where does the exceptional voice fall on this continuum?

We suggest that the current model of vocal assessment and treatment is not representative of the full capacities of the human voice, as we know that even the normal voice can be enhanced and improved.[169] The range of potential improvement or decline possible among elite singers is even greater. Our first thought was to propose a reconfiguration of how we look at voice by adding the exceptional voice of the singer and actor to the right side of the voice continuum (Figure 3.2).

Figure 3.2 – Extending the Current Model

However, even this addition did not adequately distinguish the potential categories of voice including 1) the typical voice, 2) the trained voice, and 3) the exceptional voice. In fact, we needed a new model that would allow us to better represent the full capacities of the human voice and the tolerance to withstand a voice disorder. We therefore suggest an entirely new visual model (Figure 3.3) that will take both the speaker and the speaker's tolerance for a voice disorder into account. It is a model that will distinguish typical voice from the more trained and elite voice users and better represent the need for clinical voice rehabilitation and habilitation needs.

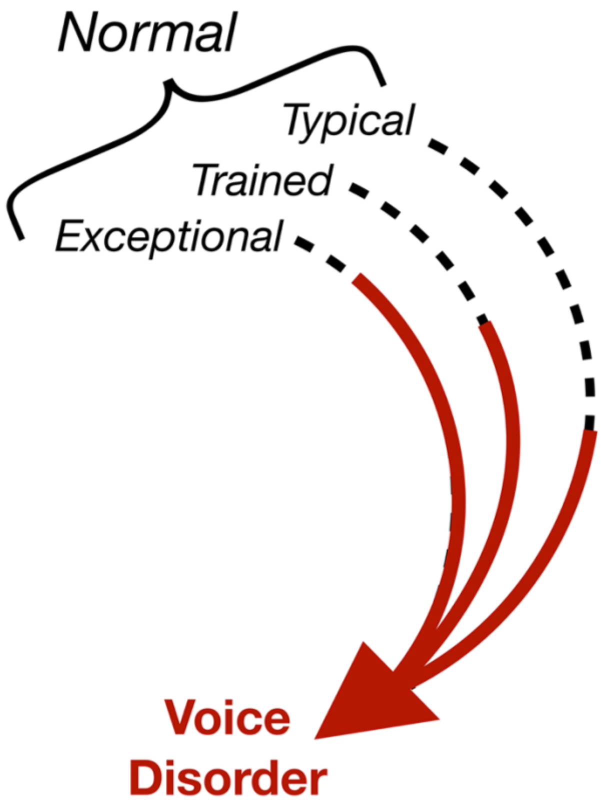


Figure 3.3 – The New Voice Production Continuum. The black dashed arcs represent the range of tolerance acceptable for a given voice user before that individual considers their voice as causing a problem. The red solid arcs represent the range of disorder severity by each class of voice user.

We know that the amount of decline needed to deviate from "normal" is not on the same scale for the typical, trained, and exceptional voice. A typical voice is defined as the voice that does not have significant vocal demands – a voice that can withstand greater deviation (as illustrated by the dashed black lines in Figure 3.3) from "normal" before being considered disordered (red lines in Figure 3.2. The typical voice represents the current clinical model. A trained voice is one that may have had additional voice study which could be in the form of singing or acting lessons and specific vocal training for the given genre or occupation. Such a person does not fit the definition of the exceptional voice, but is clearly functioning at a higher level than the typical voice. The trained voice can withstand some deviations from its normal, but not as much as the typical voice due to the increased demand on the system (Figure 3.3). Wellens and van Opstal (1998) discuss how vocal artistic performance by elite vocal professionals (exceptional voices) demands an enhanced vocal quality, and increased range, dynamics, and prosody compared to other voices. The exceptional voice can allow even less of a decline from “normal” before it is considered a vocal disorder. This expansion of the original continuum illustrated in Figure 3.1 will allow for a rehabilitative focus on the exceptional voice by acknowledging that any changes or deviations from their individual “normal” is recognized as a decline in vocal status and warrants intervention with the focus of returning the voice to its relative state of “normal.”

Rehabilitation for the Exceptional Voice

When elite physical athletes such as professional basketball or football players are injured, the focus of rehabilitation is on “return to play”.[211] The goal is to rehabilitate to a pre-injury level of performance. Similarly, when elite vocal athletes, experience vocal impairment, the goal of rehabilitation becomes "return to perform".[25] Singing and vocal performance, at first glance, appear inexplicitly intertwined; but the two are actually separate entities, equally important to the development of the exceptional voice. Artists themselves appear to consider their singing, or rather, their “vocal abilities” as something separate from their performance. While the general public might consider the unique vocal qualities that each singer possesses as a special gift, many elite vocal athletes have a self-conscious and unpretentious perspective on their voice; they don't think they possess anything special, almost to the extent of an imposter syndrome.[1] As a high-level achiever, the fire that drives them to become an elite performer often necessitates developing complementary skills. Such skills may include song writing, maximizing the vocal abilities that they do possess, and/or using acoustics to enhance their final output—the performance. Realizing self-perception of limited vocal prowess is especially important when examining how singers and actors accommodate to changes in their voices and the angst they face when trying to reconcile such changes with performance during the rehabilitation process.

Because of extreme financial implications and issues related to reputation and dependability, elite vocal athletes often do not have the luxury of taking several weeks or months off a tour to rest their voices or participate in vocal rehabilitation. Performing with a compromised vocal mechanism significantly increases the risk of further vocal injury and less than optimal performance quality.

For the exceptional voice user, the goal of rehabilitation is to "return to perform". This is with the understanding that "performance" may be within the context of many different performance venues. Similar to the rehabilitation of elite athletes, the rehabilitation of elite vocal athletes needs to be both systematic and specialized to the individual. There is no "cookie cutter" approach that will provide optimal results with this population. Each elite vocal athlete is unique regarding vocal abilities, vocal demands, and performance demands. When the focus is on “return to perform,” the rehabilitation process should be centered on training artists in a manner consistent with their unique vocal style that facilitates the continuation of maximum performance in this style with minimal vocal cost.[25]

Clinical intervention may range from surgical intervention, voice therapy, total vocal rest, modified vocal rest, modified vocal and performance demands, and/or decreasing vocal load. The care team for singers with exceptional voices should, ideally, include both a laryngologist (ENT specialized in voice care) and a speech-language pathologist (SLP) specialized in caring for the professional voice. This multi-disciplinary team will work with each other and coordinate and lead the rehabilitation process. Once cleared by the ENT to work on voice, the SLP will begin vocal rehabilitation to address the specific vocal concerns. This should include a focus on physiological voice therapy designed to strengthen and rebalance the vocal mechanism, along with vocal hygiene and voice exercises. This holistic approach has the goal of vocal rehabilitation for the elite vocal athlete while maintaining what makes their voice so unique and marketable. This team will often also include a singing voice specialist, voice teacher, vocal coach, or vocologist who plays an integral part in the habilitation piece of the journey. This team will work together to provide multi-dimensional and comprehensive care for the exceptional voices of professional voice users and elite vocal athletes.

Summary

We have identified and defined the exceptional voice as one that is highly trained to the demands of a particular aesthetic and that possesses unique vocal characteristics and abilities that differentiate the voice from those of the general population. Voice disorders in elite vocal performers often fall outside the typical definition of a voice disorder and therefore do not usually qualify for third party support for rehabilitation services.[209] This lack of support is without merit as we know that for exceptional voices, a deviation from their normal *is* a change in their vocal status and can lead to high-impact consequences, the worst of which can be career ending. It was our intent to redefine the voice production continuum to include this unique population by expanding the current model of vocal assessment from normal to disordered to include a proposed new vocal continuum which includes the typical, trained, and the exceptional voices. Vocal rehabilitation for the exceptional voice should be as unique as each of the performers themselves. It should focus on the rehabilitation goal of “return to perform” and include a multi-disciplinary team of highly trained voice specialists from both the medical and artistic arenas throughout the rehabilitation and habilitation processes while working to maintain the integrity of the performers’ vocal abilities, vocal demands, and performance demands.

The exceptional voices of the world have the potential to bring us, the audience, exceptional performances. These elite vocal athletes have the ability to bring us joy, to make us cry, to challenge us to ponder difficult or new ideas, and allow us to escape from life for a short time. Losing any part of their voice not only affects their vocation, but also the very essence of identity as an artist. It is our burden to provide specialized rehabilitative and habilitative care for these elite vocal athletes that focuses on the return to perform and optimization of their exceptional voice, as exceptional voices require exceptional care.

This initial stage of the dissertation has identified the difficulties that singers can experience when seeking professional clinical treatment for voice problems. These singers are currently at a disadvantage in obtaining clinical services because they do not meet current clinical requirements for a voice disorder. This manuscript was developed to address this need by proposing an expansion of the voice production continuum to include the exceptional voice. The paper was published in the American Speech-Language Hearing Association peer-reviewed journal *Perspectives – Voice & Voice Disorders* in order to begin this discussion and, ultimately, change the industry standard. This problem becomes a larger issue when elite vocal athletes begin to experience "normal" aging vocal changes. They are already functioning at a level that is unquestionably above "normal". Aging vocal changes are frequently thought to be "part of getting older" and as a result, often no specific treatment is recommended. Before exploring potential treatment strategies for the aging elite vocal athlete, we explore voice and performance changes and how they are currently being accommodated.

CHAPTER 4: AGAINST THE WIND – SINGERS GROWING OLD

Chapter 4 presents a qualitative study, Against the Wind – Singers Growing Old. The second component of the dissertation presents this study as published in the *Journal of Singing.* This study utilized a content analysis of 73 autobiographies and biographies to explore the perceptions of singers as they experience and accommodate to age related vocal and performance changes. The analysis provided a unique peek into the lives and experiences of aging elite vocal athletes and the struggles they encounter as they continue to perform before the final curtain falls. Four overarching themes were identified from the singers' self-appraisal of their vocal and performance capabilities in their later years. The data capture the raw emotions of these performers and identifies a need for supportive interventions across multiple platforms to help keep them singing until the end.

Sloggy, J. & Rowles, G. (2019). Against the Wind – Singers Growing Old. *Journal of Singing,* 75(5), 535-551.

https://www.nats.org/_Library/JOS_On_Point/JOS-075-5-2019-535_-_Against_the_Wind_-_Sloggy_-_Rowles.pdf

ABSTRACT

As they grow older, contemporary commercial singers experience potentially traumatic and career influencing vocal and performance-related changes. Employing content analysis of 72 autobiographies, this qualitative study explored the perception of singers as they experience and accommodate to such changes. The study identified four overarching themes in singer's appraisal of age-related vocal changes: modest self-perception of their vocal prowess and its relationship to performance, acute sensitivity to changes in vocal quality, recognition of the critical association of voice quality with their identity as a performer, and an array of accommodations to age-related vocal changes. These transitions are framed from a life course perspective against the backdrop of the demands of a changing music industry, limited access to and use of clinical interventions, high and sometimes unrealistic audience expectations, and differing levels of responsibility of each of these constituencies. There is a need to provide empathy for the changes experienced by aging singers. Supportive intervention that maximizes vocal performance and singer wellbeing is especially needed during the twilight of their careers as they continue to share songs that inspire and enrich the lives of their audiences.

Keywords: aging singers, autobiographies, content analysis, presbyphonia, vocal accommodation, empathy

Against the Wind: Singers Growing Old

JoAnna E. Sloggy & Graham D. Rowles

> *"There's no template for growing old as a rock star. There's no pattern out there that you can follow. We were the first to come this way, flaunting our youth as we did so, and we've got no choice but to be pioneers going out the other end, when youth has ceased to be an option."*[212]
>
> *Rod Stewart*

Introduction: Growing Old as a Singer

Singers grow old. As they enter the twilight of their performance careers, most grapple with accommodating to changes in their voice and anxiety about continued ability to perform as they did during the peak of their career. Changes with aging are more than simply those associated with moderating an extravagant and flamboyant lifestyle. It is no secret that the world of performing artists often includes smoking, drinking and illicit drug use;[213] indeed, some singers view such a lifestyle as part of their identity as a performer. They may come to think that such an identity contributes to their success and resist changing their behavior for fear that it will negatively affect their reputation and performance. But they may also come to realize that such a lifestyle can affect the voice. They tread a fine line between maintaining an image while at the same time sustaining optimal vocal performance. As they grow older the effects of these aspects of lifestyle are supplemented by aging related changes over which they have limited control, such as reduced stamina, normative age-associated vocal changes that include more limited range, vocal fatigue, and vocal quality,[32] as well as difficulty accommodating to evolving performance expectations in the changing environment of the contemporary music industry.

Despite these challenges, most singers are driven by an imperative to ply their craft for as long as possible; indeed, for some, death on stage is viewed as a fitting exit. This study is an exploration of the aging voice from the perspective of the lived experience of singers. Enhanced by the singers' own words, we consider complex relationships among the aging concerns of the voice, continuing ability to perform, and the essence of singer identity. Our focus is on the contemporary commercial music (CCM) genres of pop, rock, folk, blues, jazz, country, soul and musical theater. As the nature and context of vocal performance in classical music is uniquely different in training and performance demands, it has been excluded from this discussion.

Using material from singer autobiographies and journals, we document ways in which singers recognize and accommodate to vocal and performance-related changes associated with aging in the context of almost universal acceptance of a responsibility for not letting the audience down. Our findings are interpreted within the context of a music industry that has ever growing capability to remake singers through digital technologies and to reframe their modes and venues of performance. Implications for singers with respect to the potential for assistive clinical intervention are explored. Finally, based on our findings, we advocate for public education and acceptance of the challenges facing aging singers and suggest a need for deeper empathy with artists as they seek to negotiate the final stages of their careers in ways that maximize their legacy.

Methods

A qualitative research design, focused on revealing the values, meanings, and intentionalities underlying singer perceptions and behavior, was employed to address the objectives of the study. This approach is grounded in a distinctive philosophy of understanding human behavior from the perspective of lived experience and an associated array of methodologies designed to reveal essential dimensions of such experience.[214] Specifically our methodology involved critical content analysis of the autobiographical writings of performers with particular focus on comments pertaining to the aging of their voice and its impact on their performance. Priority was placed on material derived from autobiographies written independently rather than in collaboration with co-authors or ghostwriters, since we wanted to report, as much as possible, on the authentic unfiltered thoughts of the singers. While the focus was on personally written autobiographies, some methodological triangulation was achieved by incorporating insights from published commentaries of inner circle colleagues and observers, often fellow performers.

A total of 73 autobiographies and memoirs were reviewed (see AppendixI-III). Within 14 of these books, we found no reference to or commentary on the quality of the writer's singing voice or changes that had occurred or were anticipated in their performance as a result of aging. This finding was noted when the source was entered into our data base. In cases where a potentially relevant passage was identified, it was copied verbatim into the data base.

Data analysis was inductive and iterative: it involved independently reading and re-reading the identified passages in the data base by each of the authors. Weekly meetings between the authors, over a period of several months, facilitated coding based on the general principles of comparative analysis.[215] The goal was to identify consistent themes in the data. We began with open coding. Each author reviewed all of the passages in the data base and identified specific sentences that seemed to pertain in some way to some aspect of the overall theme of the project, exploration of the performance-related implications of the aging voice. A second phase of analysis conducted during face-to-face meetings, axial coding, involved grouping individual observations into a series of categories. Finally, the categories identified through axial coding were organized using a process of selective coding into a set of broad themes that told the story of the data in terms of a set of overarching constructs representing vocal artist's perceptions of the nature and implications of their aging voice with respect to vocal performance.

Findings

As they move toward the end of a performance career, successful vocalists often write autobiographies and memoirs in which they document their stories. Such writings provide often poignant insight into the manner in which they reconcile voice changes with their performance as an aging singer. Some of these published accounts are little more than ghostwritten self-serving sensationalized public relations efforts oriented toward keeping the performer in the public eye, generating supplementary income, and nurturing and sustaining an adoring fan base. Other publications contain thoughtful, reflective and deeply profound ruminations and insight. They present personal glimpses into the identity of the performer. Within this latter group of accounts, we discovered passages of writing that shared autobiographical insight into the lived world of the aging singer. These passages revealed singers acknowledging and confronting the aging of their voices and grappling with fears and anxieties about their continuing ability to perform at the highest level.

Our findings of singers' perception of the nature and implication of their aging voice are presented within the rubric of four overarching themes: *self-perception of voice, sensitivity to changes in vocal quality*, the critical association of *voice with identity*, and *accommodations to aging-related vocal changes.* Each theme embraces a number of sub-themes.

Self-perception of Voice

With few exceptions, singers are surprisingly modest about the quality of their voice. Kim Gordon (2015, p. 127) wrote, *"I've never thought of myself as a singer with a good voice, or even as a musician."* 216 As Bruce Springsteen phrased this,

> *"About my voice. First of all, I don't have much of one. I have a bar-man's power, range and durability, but I don't have a lot of tonal beauty of finesse. Five sets a night, no problem. Three and a half full-on hours, can do. Need for warm-up, light to none. My voice gets the job done. But it's a journeyman's instrument and on its own, it's never going to take you to higher ground." (p.493) 217*

Frank Sinatra was similarly self-effacing, *"I discovered very early that my instrument wasn't my voice. It was the microphone." (p. 111)*[218] Billy Joel admitted that,

> *"For starters, I've never thought that I had a good voice. I can be objective about it. I like it better now that it's thickened out more at the bottom end than when I was younger, but I don't compare it to those naturally compelling voices I came up listening to. I can sing in key; I can sing in pitch. I can growl it up or rock it up or soul it up, but my natural voice, to me, is sort of like a kid singing in church." (p. 35)*[219]

Recognition of vocal limitations can lead to anxiety, especially when audience expectations are high. Alan Cumming wrote,

> *"But I am not one of those singers. You know, the Broadwaaaaaaay belters, the beautiful singers. And even worse, since I have been on Broadway and even won a Tony award for Best Actor in a Musical, I felt that more and more people expected me to be one of those singers. They expected me to have that sort of polished sound. And I just don't. I don't want to, mind you, but one of the troubles with becoming more and more well-known (and in this case well known for something you don't feel very confident about) is that you feel there is more and more of a chance you will disappoint." (p. 228)*[220]

Many singers consciously compensate for perceived vocal limitations by seeking to enhance other aspects of their performance. Bruce Springsteen was particularly eloquent in articulating this sentiment.

"So I figured if I didn't have a voice, I was going to really need to learn to write, perform and use what voice I had to its fullest ability. I was going to have to learn all the tricks, singing from your chest, singing from your abdomen, singing from your throat, great phrasing, timing and dynamics. I noted a lot of singers had a very limited instrument but could sound convincing. I studied everyone I loved who sounded real to me, whose voices excited me and touched my heart. Soul, blues, Motown, rock, folk; I listened and learned. I learned the most important thing was how believable you could sound. How deeply you could inhabit your song." (p.494)[217]

Later, he wrote, *"My vocal imperfections made me work harder on my writing, my band leading, my performing and my singing. I learned to excel at those elements of my craft in a way I might otherwise never had if I had a more perfect instrument." (p. 495)*[217]

Changes in Vocal Quality

While aging is a uniquely individual and personal experience, artists experiencing vocal changes are typically forced to experience them in a very public fashion. Comparison of recording of singers made at different points in their career, from their youth to later years, clearly reveal these changes in vocal quality, often first noticed by artists in a truncation of their upper range. Phil Collins commented,

"By this stage, I'd been dancing around the high notes for a while. This didn't happen so much on my solo tours since my music was written for me to sing… But even if Peter [Gabriel] *had been singing them, they*

would have been high even for him at this point in both our lives." (p. 301)[221]

Ricky Skaggs wrote, *"There was one track, "Your Love," on which I recorded several harmony parts, including a vocal so high Buck said, "That's as high as a dog whistle!" I wish I could my voice up there now!" (p. 269)*[222]

For an elite vocal athlete, even a few notes lost from their range can cause significant difficulties when performing songs from their albums, many written when they were younger and having little difficulty reaching higher notes. Billie Holiday, for example, experienced vocal decline in her later years.

> *"In the last decade of her life, her voice beginning to coarsen and her range narrowing, she crossed over to Norma Granz's Clef and, later, Verve Records… Being marketed to a national audience was an enormous advantage to her, but it also meant that she would have to avoid current pop songs that were sometimes ill-suited to her, and she would not be able to depend on the near-blues songs that were still in favor in the black community. … By 1958 her health worsened and her voice had changed so much that she relied on little more than a bare recitative in which only her phrasing, her timing, and a few of her vocal characteristics remained intact." (p. 127-128)*[223]

Shift in the overall quality of vocal output is often noted as decreased loudness, pitch instability, decreased range, and changes in vocal fold vibratory parameters, alterations that may be due to physical changes to the vocal mechanism. Such changes can potentially be career ending for an artist if they become severe. At age 74, Jerry Lee Lewis was still performing while adjusting to the hands of time.

> *"By the late 2000's, he knew that his voice was changing, ever changing, but it still sounded like him, and his hands were still able to do many of the acrobatic moves of his youth. If it looked a little slower, well that was his intent. Even well-meaning people believed he was surely done by now; surely, he would soon succumb to all that hard living, or at least, growling in disgust, finally retire. Still, when he walked into a hotel room for an interview, reporters seemed surprised somehow that he had actually gotten old. They described his face as wattled, his voice as high and thin; they described a newfound humility when he performed onstage, and an increased carefulness with music that now suddenly was not a guarantee." (p.454)*[224]

Johnny Cash was acutely aware of how changes in his voice might be perceived by his audience.

"When I first appear, they might be thinking, I didn't know he was getting that old," or "Wow, he sure gained weight," but by the second or third song they should be coming around a little. "Well, he doesn't move around as much as he used to. He's slowed down a lot, but he still sings fairly well. For an old guy anyway." (p. 272)[225]

Voice and Identity

Motivation for Singing

Most singers view their voice as far more than a tool for pursuing a vocation; it becomes the essence of their persona and an integral part of their identity. To sing is to be alive; there is really no alternative. As Rod Stewart expressed this, *"After all, the performing—it's who I am. It feels like what I was put down here to do. If I go a month without a concert, I get all jittery and miss it." (p. 359)*[212] Tina Sinatra described how her aging father, as his age peer friends began to die around him, would say, *"If I stop working, I know I'll be next":* she writes *"Music was his life force, what was left of his identity. The audience was where he lived." (p.229)*[218] Tony Bennett recounted how the jazz vocalist Joe Williams once told him, *"It's not that you want to sing; it's that you have to sing." (p. 239)*[226] He identified with this sentiment, *"And it's true – I have to do it. I can't think of a nobler occupation than to try to make people forget their problems for an hour and a half. You lift up their spirits and give them a feeling of hope. That's what a good psychiatrist does to help patients." (p. 239)*[226]

This notion of singing not only for the self but because it somehow helps the audience, sometimes in profound ways, becomes a motivation that can reinforce a performer's inherent personal imperative to sing. It can be affirming and foster a sense of belonging and purpose. As Gregg Allman wrote,

> *"What you can do is make them forget their problems for about three hours – and there's a shitload of problems out there, man. … We flat-out make them happy. Stomping their feet, clapping their hands,*

dancing around and smiling, lighting up their cell phone and Bic lighters – that kind of happy. I just love to see that, because it makes me feel like I belong, and everybody needs to belong to something. (p. 370)[227]

Joe Perry of Aerosmith expressed a comparable perspective in describing how an inherent imperative to sing is reinforced by audiences in a manner that is not only self-affirming but also—through the way in which it may uplift an audience—can become transcendent, a phenomenon beyond the individual performer.

> *"…we kept working for the music, for the fans, for the money. We did it out of habit, we did it with ambivalence, but mainly we did it because our passion for the music drove us. Today that passion still makes us feel like eighteen-year-olds. But mostly seeing a fan wrap his or her arms around one of us and hearing words like 'Your music got me through rehab … Your music kept me afloat … Your music saved my life' That's strong stuff. Steven's antics, my arrogance, all the stuff that went on with the other guys – it all pales against the knowledge that long ago this band became something bigger than all of us." (p. 363)*[228]

For some aging singers, performing is so integrally intertwined with identity that it is difficult to give up. To stop singing is to lose identity. Bob Dylan said, *"There's a certain part of you that becomes addicted to a live audience … I wouldn't keep doing it if I was tired of it." (p. 461)*[229] This aspect of motivation was also captured by Tina Sinatra in describing her father's final years as a performer.

> *"His antidepressants might not be working too well, but his public lifted his spirits each time he took his bows. Dad was fighting not to lose*

himself. The stage was his last bastion, the place where he was the most comfortable and in control. As his powers diminished, he held tight to the edge of the precipice." (p. 229)218

Rod Stewart expressed a similar sentiment when confronted with the possibility of having to give up singing. *"Yes, but no more singing, no more records, no more performing ... How easy would it be to let all that go? And what would remain of me, in its absence? "Didn't you used to be Rod Stewart?" (p. 322)212* Namoi Judd, describing giving up singing, poignantly wrote,

"I felt as though the joy that the world had given me so much of through performing for the past year had evaporated before my eyes, leaving me a deflated woman without any sense of purpose. It's said that when you lose Shangri-la, you turn old and gray. I had lost my identity." (p. 41)230

Meeting Expectations: Not Wanting to Let People Down

Beyond self-perception, a clearly revealed component of singer identity is a desire to avoid letting down or disappointing their audience. As they grow older, singers become increasingly aware of expectations that fans, producers, managers, audiences, and the music industry have of them. They become conscious that their music, although it remains an integral part of their personal identity, transcends ownership; it doesn't belong to them anymore. As Phil Collins, in many ways echoing Joe Perry, has often been quoted as saying, *"Beyond a certain point, the music isn't mine anymore. It's yours."*

Expectations increase with success, sometimes to the point where they seem unattainable. Phil Collins wrote about Elton John's struggle to meet these expectations and his acceptance of this responsibility during a show when facing vocal problems,

> *"In Australia, our routing overlaps with that of Elton John. … Elton throws a moody because he thinks he's lost his voice. It looks like he's about the pull the gig, no matter how this might impact on the dozens of orchestral players and the tens of thousands of fans. He calls for his limo, is driven round the car park in a low-speed huff, but in the end, comes back and takes the stage." (p.301).*[221]

B.B. King wrote of the visceral reaction he experiences and the lengths, often dangerous, he goes to in order to meet expectations. *"If I feel I'm gonna miss a gig my blood starts boiling. It might be unavoidable; the bus broke down or the plane's grounded or the highway's covered with ice. But I'll find a mechanic or charter a plane or brave the ice rather than disappoint a promoter and let down a crowd. That's just me." (p.224)*[231]

Artists continue to struggle with these expectations as they age. In their later years, they have typically been working in the industry for decades, often since they were in their teens or early 20s. They have usually released numerous albums over the course of their career and many of their songs have become hits. Audiences are very familiar with these recordings and go to concerts expecting to hear the music they love just the way it sounds at home. This expectation can set up a difficult situation for the artist if they are no longer able to perform the songs as they did in their youth but know that the audience will be expecting to hear them sounding just like they do on the recordings.

John Szwed noted how Billie Holiday struggled with this dilemma over her career. "*It might not seem surprising that a singer would change her interpretations over the course of a twenty-six-year career, but the demands of aging fans who expected her to sing the same songs in the same way are often abided by, though sometimes with disastrous results." (p. 128)*[223] Describing her later work, he wrote, *"She was imitating herself, the curse of the aging artist." (p. 192)*[223]

Lifestyle & Identity: Alcohol, Smoking, Illicit Drugs

Many singers have spoken openly about their use, struggles with, and changes in lifestyle linked to smoking, drinking and illicit drug use. Gregg Allman explained how alcohol addiction was affecting his voice and describes his realization that he needed to change.

> *"My voice was suffering as well, but I managed to get through the taping. … A little voice told me that enough was enough, and this time I listened. I gave in and told them I would go* [to treatment]. *I resigned myself to going at the end of the week, but until then, I just kept right on drinking, man – I drank constantly. I couldn't not drink, you know? Sad, but true: I couldn't not drink." (p. 4)*[227]

While some singers are aware of the ill-effects of smoking, drinking, and illicit drugs, the myth endures that smoking can influence your voice in a positive way. Keith Richards reflected on this during a published interview.

> *"Are you still smoking 100 cigarettes a day?" – "No, I never have smoked that much. I tend to smoke a lot more when I'm working. It's about a pack a day. It depends. Sometimes I go off them. But you know, Aretha Franklin and Dionne Warwick both smoked loads more and have wonderful voices, so maybe I should." (p.182)*[232]

Often, as they age, singers are no longer able to continue the destructive behaviors of their youth. Multiple factors force them to consider the cumulative effects of past choices and their aging. In writing about Frank Sinatra, Taraborrelli explained,

> *"Meanwhile, in his private life, Frank was also seeing significant changes. His hair, for instance, had become a source of irritation. He despised the toupees he felt forced to wear to cover his baldness. He had gotten a hair transplant; however, it didn't "take". Also, he was gaining weight and blamed rich Italian foods, but dieting was out of the question. And he was tired more often. He could no longer drink liquor all night long and then be able to fully function the next day, as he had done for years. His voice was weakening; years of smoking Camel cigarettes had done some damage to it." (p. 386)*[233]

Rod Stewart openly acknowledge a history of drug use as an element of his persona and his initial denial of how it might affect his voice. *"This was when I was introduced to serious cocaine– proper, extremely high-quality stuff. ... You were using it more like snuff, to pep the evening along. ... — and no sense for me, slightly deluding* *myself, that something so pure could possibly be damaging my voice." (p. 358)*[212] He reported lifestyle changes as he aged with increased focus on healthy behaviors.

> *"Outside of football, I don't worry about aging so much. I look around at people I've worked with down the years and I think, relatively speaking, that I'm not doing too badly. … And I'm sensible in my habits: the right food, a glass of wine or two with dinner, but no more. And, of course, no drugs. Cocaine ended form me in the early 2000s, by which time I was hardly touching the stuff in any case. … But even in those tiny quantities, I realized it was getting to my voice—drying out the membranes. (p. 358).*[212]

Some singers acknowledge how they self-medicated with alcohol and drugs to address performance anxiety. Some are able to overcome those addictions. Neil Young shared his struggles with song-writing after quitting and how his substance abuse allowed him to avoid facing himself.

> *"Not that it matters much, but recently I stopped smoking and drinking. I am now the straightest I have ever been since I was eighteen. The big question for me at this point is whether I will be able to write songs this way. I haven't yet, and that is a big part of my life. Of course, I am now sixty-five, so my writing may not be as easy-flowing as it once was, but on the other hand, I am writing this book. I'll check in with you on that later. We'll see how it goes. … When I stopped smoking weed I*

threw in drinking too, because I had never stopped both simultaneously and I thought it might be nice to get to know myself again. (p.9)[234]

After quitting drugs and/or alcohol, some artists face a reframing of their identity as performers as they grapple with learning how to function as a sober artist. This can cause additional problems such as increased performance anxiety. They, like Neil Young, may also fear decreased artistic creativity. If self-abusive lifestyle behaviors have been a part of a coping mechanism for dealing with performance stress, singers may find themselves simultaneously confronting learning how to perform again at the same time as they are dealing with aging-related vocal changes.

Fear of Losing Voice

Fear of the possible consequences of positive lifestyle changes on their identity as a performer is one component of a larger concern. Given the priority placed on singing, it is not surprising that, throughout their lifespan, singers report being acutely aware of a fear of losing their voice. As their careers begin to take off and demands of their voice increase, this fear can grow as the realization of how losing their voice would have an immediate impact on many people. Carole King articulated this fear in describing in a performance in 2005. *"But these are minor problems compared to the sensation I feel in my throat, the one I get when I'm about to lose my voice. How can I give my audience what they've come for if I don't have a voice?" (p. 1)*[235] Phil Collins noted this earlier in his career, when the number of shows increased. *"Now that I'm playing so many shows, solo and with Genesis, and increasingly in large venues, I live in fear of losing my* *voice…" (p. 224)*[221] As singers become aware of how losing their voice can bring immediate and potentially longer-term plans to a halt, they often become sensitive to what they can control to reduce this risk including vocal hygiene and vocal exercise. There is also increased understanding of factors that may be out of their immediate control, including touring schedules and contracts obligations.

Fears are accentuated when singers are confronted with surgeries that might affect their voice. Bruce Springsteen articulated this fear in describing surgery for cervical disc problems.

> *"The surgery went like this; they knock you out; cut an incision in your throat; tie your vocal cords off to one side; get in there with a wrench, screwdriver and some titanium. … Because all of this takes place around the vocal cords your voice is gone for a couple of nerve-racking months." (p. 492-493)*[217]

Rod Stewart described similar anxiety associated with his surgery for cancer.

> *"In order for the surgeon to get to the tumor, it had been necessary to cut through the muscles in my throat. … Give it three months of rest, the doctor said, and I could fully expect some kind of singing voice to return. Phew. Of course, it might not be the same voice. … Ah. So, what if the voice I got back was a different voice? What if the voice I got back was the voice of—for example—a not very good singer? I didn't want any old voice back. I wanted my voice back." (p. 321)*[212]

Reluctance to Quit

Some singers have a strong, almost obsessive, imperative to keep singing. Tony Bennett explains, *"I have no desire whatsoever to retire; if I'm lucky, I just want to get better as I get older." (p. 239)*[236] Naomi Judd poignantly stated, *"In contrast, my desire was to stay onstage, and my whole biological being seemed to be in turmoil because I had no alternative plan for when my career came to an abrupt end." (p. 214)*[230] Many singers share this reluctance to retire. Andy Williams wrote, *"As long as I'm singing well, I see no reason to stop. When my time is up, I'm expecting to leave the stage for the last time in a wooden box." (p. 304)*[237]

But the sentiment is not universal or unequivocal. It is tempered by realism. For example, Tony Bennett, acknowledged that changed in his voice might limit his ability to continue, but he was sanguine about this.

> *"Some singers' voices start to wobble when they get older. I once asked Sinatra what he'd do to beat wobbling, and he said he wasn't sure, but that if it ever started to happen to his voice, he'd just quit. ... If my voice does start to falter at some point, I guess I'll just become a painter." (p. 238-9)*[230]

Peter Criss wrote of his decision to retire and how important it was to him to be the person who decided it was time to quit.

> *"I sat back in the plush seat and felt like a million dollars. At least I was leaving on top. I didn't leave playing the Sandbox to forty inattentive people. I didn't leave clinging to the stage while the audience was saying,*

"Look how fat he got. And he's wearing a wig. And they're doing the same fucking songs for fifty years." (p.335)[238]

Rod Stewart voiced a similar sentiment although he realizes that the lifestyle change would not be an easy one.

"One day, in the midst of my misery, I stared out of the window and thought, 'I know, if I can't be a singer, I'll be a landscape gardener,' But even as I was hatching this unlikely plan, part of me was sane enough to understand the following: that if you've been a singer in a rock 'n' roll band, there is very little that you can do afterward that is likely to match it for job satisfaction. Singer is a rock 'n' roll band is, in my opinion, quite simply the best job in the world. It could only be a comedown after that—even if I turned out to be a very good landscape gardener indeed." (p.322-23)[212]

Accommodations

Once singers have identified deviations from their typical vocal quality they respond in different ways. Often these accommodations are the result of recommendations passed down from friends, peers, or learned from medical intervention. Accommodations described in the autobiographies included an emphasis on vocal hygiene, vocal habilitation, medical management, and performance adjustments.

Vocal Hygiene

Vocal hygiene refers to positive habits of behaviors that sustain and improve vocal health. This often becomes more important to singers as they start to experience vocal deterioration. Multiple vocal hygiene strategies may be employed. Johnny Cash wrote, *"...so as usual I have to guard my resources and energies: be careful I don't eat too much, make sure I get my afternoon nap, and avoid turmoil and distractions, protect my time as fiercely as I have to. Then I'll be able to give the audience my best." (p. 272)*[225] Mick Fleetwood described a similar focus on maintaining vocal health. *"We have no intention of running our ensemble into the ground the way we used to do; we've learned to look after ourselves. ... As for me, my job is pretty physical and I've learned my lesson. I need to stick to a healthy regime or none of this would be possible." (p.319)*[239]

Hydration

An important part of vocal hygiene is hydration. This has been well studied. The positive effect of systematic hydration is even more important for singers as hotels, airplanes, and climate changes between venues can all contribute to increased laryngeal dryness. Tom Jones experienced this when he was performing in Las Vegas. *"Get an ear, nose, and throat specialist to make a list of all the places not to sing, and I can guarantee you that Vegan will be number two on that list after the Moon. Your choice: air conditioning indoors, or parched desert air outside. Neither are working wonders for your vocal cords." (p. 389)*[240]

Steam inhalation is a component of vocal hygiene. This can be a way to help counterbalance laryngeal dryness that can occur from busy travel and tour schedules. Phil Collins spoke of the benefit of steam for his vocal health. *"Sometimes at the suggestion of the best throat doctors rock 'n' roll money can buy, I'll take myself off to the nearest steam room. Now that I'm playing so many shows, solo and with Genesis, and increasing in large venues, I live in fear of losing my voice, and the steam helps."* (p. 224)[221]

Rest

Sufficient rest is important for overall health, but often very hard to maintain due to the incredibly packed schedules of singers when they are on tour. Cher was reported to have difficulty maintaining her stamina during one of her tours.

> *"A tour on this scale would have been hard on any artist, but Cher was by now fifty-three years old, and although she had no shortage of energy, the physical strain was beginning to take its toll. By the end of July, after a month and a half of performances, Cher was so exhausted that she had to postpone her shows. … By early August, after a recuperating break, she was well enough again to resume the tour and reschedule the cancelled dates." (p. 227)*[241]

Johnny Cash became acutely aware of this need.

> *"Now it's time for my nap. I'm working tonight, and if I'm not rested, it will be a mess. I'll feel bad, I won't sing well, and the people won't get their money's worth. Billy Graham taught me that: if you have an evening concert, he said, take yourself to bed in the afternoon and rest,*

even if you don't sleep. It was the most valuable advice I'd had in years, maybe ever." (p. 56)[225]

Rest involves not only sustaining the physical stamina to maintain the grueling demands of a tour schedule but also providing respite for the vocal folds. As they grow older, many performers increasing rest their voices during the day; they take vocal naps to preserve their vocal mechanism and minimize the risk of avoidable overuse. Carol King discusses how she lets other know she is resting her voice during her tours. *"This is a lanyard with a hand-lettered laminated sign that says "Voice at Rest." It explains to others why I'm speaking only in hand signs and whispers, and at the same time remind me not to speak unnecessarily" (p. 2)*[235] She goes on to explain how this has the associated benefit of conserving her energy.

Avoiding Phonotraumatic Behaviors

While some performers embrace vocal rest, others, despite the advice of those surrounding them, consistently engage in vocally demanding behaviors including yelling, screaming, vocal overuse, throat clearing, loud talking, and grunting. Such phonotraumatic behaviors can compromise the integrity of the vocal fold causing (at least) mild swelling of the vocal folds or (at worst) a laryngeal pathology. Joe Perry wrote of encouraging Steven Tyler to use vocal rest when he was having vocal problems. *"He used to say, "You can change guitar strings, Joe, but I can't change vocal cords." "That's true," I'd reply. "So why are you shouting and screaming on your off days? Why* *aren't you resting your voice?" (p. 332)*[228] Rod Stewart also wrote of damage from vocal overuse.

> *"Going out on the road for at least six months of every year was my idea of a life well lived, but it was clearly beginning to take its toll on my vocal cords—sensitive enough little things in the first place. And if they rebelled, I genuinely was going to be fucked. But could I do? The band played so loudly. We kind of prided ourselves on it. The volume at which we played was a badge of honor. … Night after night I was forcing my voice to compete with that volume, and by the end of the show I had commonly blown my throat out. The next day, I would walk around feeling as though I had been gargling barbed wire. Then it would get to 6:00 P.M., two hours before the next show and I would realize that I simply didn't have a voice to sing with. The situation was not a particularly healthy one: I started taking steroids." (p.281)*[212]

Avoiding Reflux and Allergy Triggers

A final component of vocal hygiene is the conscious avoidance of environments and situations likely to accentuate the effects of health conditions and allergies. A few singers described how they were vulnerable to laryngopharyngeal reflux (LPR), post nasal drainage, and allergies. They were aware of the risk that an episode might negatively contribute to vocal quality changes. Indeed, singers who suffer from LPR, post nasal drainage, or allergies are generally advised to become aware of the triggers that might provoke an episode and to avoid them because the long-term consequences can be serious overall health and vocal problems. For example, Mike Love wrote about making dietary changes, *"In the late 1990s, I was all too often experiencing congestion, so I eliminated my beloved coffee ice cream and my Tillamook sharp cheddar cheese, which I've enjoyed all my life." (p. 417)*[242]

Poor vocal hygiene including overuse and phonotraumatic behaviors are frequently noted to start in the early years of a singer's career and continue, often worsening, as they grow older. Many singers seemed oblivious to the risk that a history of vocal abuse might compromise their vocal health and ability to perform as they grew older and might even lead to career ending vocal pathology. But we discovered that some singers had become increasingly aware of the importance of vocal hygiene as they had grown older. Several of these singers complemented their vocal hygiene behaviors with vocal habilitation.

Vocal Habilitation

Some singers enter their later years with well-established vocal exercise habits and an understanding of the benefits of exercises on the vocal mechanism. This may have been learned from vocal teachers, coaches, or from other musicians. Tony Bennett wrote about how he works to keep his voice from "wobbling" with old age. *"To avoid that, I work every day doing my scales, and I really concentrate on holding my notes without vibrato. A dear friend and accomplished musician, Abe Katz, who was the first trumpet for the New York Philharmonic, told me that he holds notes with no vibrato, as that's the best way to keep focused so the notes remain strong and clear." (p. 238-8)*[236] Mick

Fleetwood shared changes in the vocal habits of the members of his band (Fleetwood Mac) as each member of the ensemble strove to take better care of their voice. *"Stevie takes great care of her voice and for the first time Chris is using Stevie's voice coach to take care of hers, as well." (p. 319)*[239]

In contrast, some singers report skipping vocal warm-ups, cool-downs, and vocal exercise. For some, this appears to be because the natural vocal talent that was the origin of their success has never required a focus on vocal training and exercise. They simply continue to do what they have always done until they are unable to do it anymore. Only when faced with vocal issues, often as they grow older, do they turn to voice exercises and a focus on vocal habilitation. Rod Stewart wrote how he experienced voice loss after surgery. He grew frustrated with the recommendations of his physician to "wait and see" and, after six months in this state of limbo, sought out a vocal coach (the cantor at his local synagogue).

> *"Nate came round and he showed me some vocal exercises: him at the piano, [I] sat beside him, feeling self-conscious and worried. It was like a daily workout for the voice—one that I still use today. He got me doing scales, runs, arpeggios. He forced me to make raspberry noises and humming sounds. ... He was exactly what I needed. Day after day, Nate came back, and day after day we did the same thing." (p. 323)*[212]

Steroids

In an ideal world, singers with vocal injuries of any kind would be allowed the recommended time for full vocal rehabilitation. That could include total vocal rest, modified vocal rest, decreased performance demands, and/or limitations on vocal use depending on the diagnosis. Unfortunately, in the world of elite vocal athletes, singers face immense internal and external pressures to perform regardless of the long-term implications for their vocal and overall health. When problems arise, they may look for "quick fix" solutions to alleviate symptoms. For some, the quick fix is steroids. Singers are often uninformed of long-term consequences of steroid injections. In the world of the immediate, they may view steroids as a magic elixir because "the show must go on." Phil Collins wrote of his steroid abuse and its long-term consequences.

> *"Mercifully while I never suffered from modules on any of the giant Genesis or solo tours in the eighties or nineties, I did have a doctor in every port. I very rarely canceled shows, because I knew when it was time to pull the emergency cord and go for the injection of prednisone, a corticosteroid. ... Your vocal cords are very small, like two tiny coins that rub together. If they become swollen, or abused, they won't meet to enable to you sing a note. Then you're in trouble. If you keep up the abuse, in their engorged state, they eventually become nodules. But a quick steroid injection reduces the swelling and you're right as rain. In the short-term anyway. ... So you're given a shot of prednisone, injected into your bum. The steroid will get you through the show, but once you're on it, you're on it for ten days. It will also get you a lovely cacophony of side effects: psychotic mood swings, water retention, moon face." (p. 299-300)*[221]

Rod Stewart described how his steroid use tragically resulted in significant health issues, *"Steroids, as prescribed by a doctor, seemed more and more attractive. Very quickly my* *voice problems became a psychological as well as a physical one. … I would start anticipating the problem even before it arose. … And then I would take a steroid just in case." (p. 303)*[212] He goes on to talk about graduating from prednisone tablets to an injected steroid cocktail of antibiotics, steroids, and vitamin B. This led to temperament changes toward aggression and impatience with mood changes and weight gain. *"… I could hardly come out and explain what was happening. It would have been career suicide." (p. 304)*[212] When the injections were no longer effective, he added cortisone tablets and suffered an internal GI bleed that effectively halted his tour. At this point, he was forced to face the fact that he could not continue the chronic steroid use. As a result, he began to address the underlying causes of his vocal malady.

Adjustment of Performance

A final strategy reported by singers to accommodate vocal changes is to make adjustments in their singing during live performances. Joe Perry wrote, *"As we musicians get older, we need to make adjustments." (p. 333)*[228] Multiple singers talk about such adjustments. With a touch of whimsical humor, Phil Collins observed, *"The voice, however, is a different beast. You can't put a sticking plaster on iffy vocal cords. So, you have to try to transcend via other means." (p. 299-300)*[221] Linda Ronstadt explained, *"After I turned fifty, my voice began to change, as older voices will. I recrafted my singing style and looked for new ways to tell a story with the voice I had." (p. 192)*[243] Brian Wilson also discussed vocal changes in his performance as he grew older.

> *"You'd think that by the time I got to sixty I would have learned everything about singing, but that turned out not to be true at all. I keep*

learning and lots of that is about unlearning. Back in the '60's, I was absolutely obsessed with my voice. I was really obsessed with how it sounded, especially the high parts. Now I don't sing as high anymore and I use it simply as an instrument to communicate love and good vibes. (p. 254)[244]

Such global changes are often accompanied by the use of specific techniques to keep performing. One way to adjust for decreased upper range is to lower the key of the songs; but this can come at a cost. Phil Collins explained this paradox, *"You could lower the key in certain sings, but risked losing the magic. "Mama", for example: take that down too low and it really has no magic at all." (p. 302)*[221] Another approach is to maintain the original key, but re-write the area of concern. *"Even "I Can't Dance", a stupidly simple song, got tough. That opening high burst of the first chorus line—ouch! ... But singing that every night, I'd find myself skipping around the note. Otherwise the game would have been up. Shot myself in the vocal cord with that one." (p. 203).*[221] One clever adjustment is to set the audience up for a potential miss so they are impressed if you nail it and less judgmental if you don't. Billy Joel built this into his act when he was performing a song he wrote at 34 when he was 66. *"Both men seemed rather proud of the set's almost Houdini-like big dare, in which Joel warns the crowd that he may not be able to hit the high notes in "An Innocent Man." That he does it sitting down enhances the stunt, Cohen says: "Is he gonna make it? It's not just a falsetto, it's a powered falsetto." (p. 365)*[219] Finally, some singers adjust by passing the singing to the audience. Toni Braxton described using this strategy when she would forget what she was singing.

"Here's a trick that every performer knows: When you go brain dead, just ask the audience to sing along with you—fans often know the lyrics better than I do." (p. 253)[245] This strategy also works for covering notes that the performer can no longer reach. It works well because it involves the audience into the performance, paradoxically enriching the audience experience. As a last resort, when the other options no longer work, singers can completely avoid the particular song.

Pushing on Regardless

A final strategy is for singers to ignore changes occurring in their voice and to continue to sing, regardless of the actual or perceived consequences. Reflecting this "show must go on" mentality, Billy Idol wrote, *"Being an artist is about putting your fears aside and going for it. This was my code in 1976, and in 1993, and it still is today." (p. 292)*[246]

Beyond ego, the issue of responsibility is often a key element in a singer's desire to continue performing even when their voice may be failing. This responsibility, as we have noted, involves multiple constituencies. There is responsibility toward the audience and the desire not to disappoint. There is responsibility toward the ensemble, the large number of supporting personnel whose livelihood depends on the performance and who may have been with the performer for many years and have become key members of the entourage. Linda Ronstadt describes an occasion when she had to miss five performances, *"… the feeling is that the missing cast member has let down the entire production. I got back on stage the minute I could squeak" (p. 141).*[243] For some singer's this provokes genuine anxiety. Tina Sinatra captures the fear that her aging father experienced as his performance declined and he struggled to hold on.

> *"After seeing one too many of these fiascos, I went to him and said, "Pop, you can stop now. You don't have to stay out on the road. You can ease up and relax." A stricken expression passed over Dad's face and he said, "No, I can't stop. I've got to earn more money, got to earn more money. I have to make sure that everyone's taken care of." He looked genuinely terrified." (p. 229)*[247]

Some singers are aware of the dangers of performance heroism but continue on regardless. Similar to many aging professional sports athletes who play on with injuries, they consider this to be an inherent cost of their vocation—something that comes with the territory. Singers often realize that they are likely doing themselves harm, but they try to push this to the back of their mind. Phil Collins writes,

> *"Mainly though, I didn't allow myself too much time to think of these problems. For three decades I pushed on, and on, and on. What's worrying is that if I counted now all the times I've been pricked in the buttocks in the name of a good vocal performance, I'd have trouble sitting down. I'd have trouble getting back up again too: as I would one day find out, too much cortisone can make your bones brittle." (p. 302)*[221]

Discussion

Singing and Performing in Life Course Context

For most performer, singing is a lifelong vocation. Their voice becomes an integral part of their identity at a very young age. The trajectory of vocal changes over the life span does not occur in a vacuum. It takes place in a life course context in which environmental factors outside the individual play a major role. As their career develops, each singer's vocal trajectory is increasingly shaped by tour dates, an entourage of supportive personnel and the accoutrements, obligations and perils of fame. Indeed, each singer's life is framed against the backdrop of an ever-changing industry in which singing may become larger than they are, an industry in which evolving technologies are transforming the format, mediums and venues of performances. Our analysis reveals, in the words of singers, themselves, how these forces can pose a threat to singer identity and how they cope with such challenges, especially toward the end of their career.

Making sense of the themes we have identified and placing them in broader context, it is essential to remember that our findings are drawn from the world of contemporary singers and can only be applied to this genre. The findings have both practical and moral implications. There are implications for singers: how they live their lives as they grow older and encounter voice changes, and how they utilize resources available to them to sustain and accommodate to an aging voice. There are also major implications for the evolving music industry within which each singer develops a career. Finally, there are broader implications for society and, more specifically, for each of us as we idolize these singers, attend their performances, and share their journey as they grow older. Ultimately, in each of these domains, there are questions of responsibility.

Responsibility

The Responsibility of Singers

First, singers themselves have a responsibility to care for their voice and adjust wisely to aging-associated changes in vocal abilities. This involves the education of singers to focus on *their own voice* and on what makes this voice exceptional and unique. A key element is the education of singers on their vocal mechanism and vocal health and on the potential support that can be provided by voice specialists. This should start early in their career, ideally with baseline voice evaluation. Here we transition to the responsibility of singing teachers, vocologists, vocal coaches and voice clinicians.

The Responsibility of Teachers and Clinicians

All teachers and clinicians who routinely work with singers have a responsibility and obligation to these performers to provide instruction and coaching specialized to the singer's unique needs, education on vocal health, hygiene, and best practice recommendations, and habilitative and rehabilitative services. Most importantly, over all of this, there is the responsibility to *do no harm.*

Clinical intervention should include vocal health and hygiene recommendations and vocal rehabilitation exercises to strengthen, balance, and maintain each singers' vocal instrument. Such rehabilitation should always be individualized to the singer based on the unique demand of their style; exceptional voices require exceptional care. Not all ear, nose, and throat specialists (ENTs) and speech-language pathologists (SLPs) have the same skill sets and experience. Not all voice teachers, coaches, and vocologists who work with singers have the same training, experiences, and expertise. It is imperative that those providers and teachers working with professional singers have the appropriate training and experience level required of this population. The singing voice specialist SLP and laryngologist should work together as a team to provide optimal singer/patient care. This includes targeted education on what it takes for each singer to create and maintain *their* sound as they go through the maintenance and rehabilitation process. At some point during the journey (which will depend on the particular needs of the singer) this team should include a vocal coach/teacher/vocologist to help facilitate the transition from a rehabilitative to a habilitative focus. The more knowledgeable singers are about their voice and what it takes to keep in *their* ideal shape, the more they will be advantaged with respect to noticing potentially harmful changes. Regular access to comprehensive voice evaluations across their careers will, ideally, allow singers to seek out voice specialists at the first sign of aging voice changes. An early start on any needed vocal intervention or rehabilitation may reverse or delay negative consequences of vocal change. Appropriate clinical and studio support allows singers to maintain *their* voices throughout and especially during the twilight of their career.

Industry Responsibility

A third area of responsibility lies within the music industry. The landscape of this industry has changed significantly over the life course of the current cohort of aging singers. Historically, singers have taken a “radio-silent” approach to vocal injuries. As Rod Stewart writes, acknowledgement of vocal issues can be seen as “career suicide”. Why would any singer want that? Industry changes including the change to a digital music platform with a focus on streaming services rather than album sales are increasingly forcing singers to tour, not only to promote their music but also as a primary income source. Such increased demands can be detrimental to singers who are already at an increased risk of vocal injury compared to the normal population due to the intensive vocal demands of the job. When vocal load is increased to accommodate the demands of the changing music scene, the risk of vocal fatigue and injury is further increased.

Audience Responsibility

Finally, there is the question of audience responsibility. There is a need for greater education of audiences and the listening public. Increased transparency from singers about their vocal injuries is only one component of this process. It should also include increasing public awareness of both normative and pathological changes associated with exceptional aging voices and promoting deeper society-wide understanding of what it takes to sustain such voices as singers age. Speech-language pathologists, singing voice specialists, and physicians who work with elite singers have a role to play in facilitating this process by raising awareness, empathy, understanding and acceptance of vocal changes associated with the aging of exceptional voices. If the music truly does belong to all of us, isn't it our obligation to help the singers stay as vocally healthy as possible so they can continue to share their talent?

Conclusion

Although singers often seem larger than life and invincible, they aren't superhuman. There is a need to change unrealistic audience expectations that hold them to the standards and expectations of their youth. Those who are still performing in their later years are brave enough to continue, giving us the music, even if it's not at the same level as their younger years. They, too, are grappling with the passage of time and with their mortality. Rod Stewart says it best.

> *"I am under no illusions. I know that one day it will come to an end. I know that eventually—and it may be sooner, rather than later—I will reach a stage where getting out there and performing is simply no longer possible. And I don't know how I'm going to feel about that. It's been there all my life. I've given so much to it, and it's given so much back to me. I worry about the hole it will leave." (p. 356)*[212]

Like most of his peers, he shares Bob Seger's recognition that *"Well, I'm older now, and still running against the wind." (p. 356)*[212]

Summary

This study provided poignant insights, written by singers themselves, into the current practices of aging elite vocal athletes as they reconcile age-related vocal and performance changes with continuation of their career. Four themes extracted from their writings (self-perception of voice, sensitivity to changes in vocal quality, the critical association of voice with identity, and accommodations to aging-related vocal changes) delve into the nature and implications of the lived experience of aging elite vocal athletes. As identified in the previous chapter, elite vocal athletes often have difficulty accessing clinical services because they do not meet the current clinical definition for voice therapy. We have also examined anatomical changes and the physical aging of the larynx and acknowledged that these changes are viewed as a normal part of aging and are not considered to be a voice disorder. This becomes a bigger issue when we combine two components – the normal aging voice and the voice of an elite vocal athlete. Both these elements are considered “normal” according to the current clinical service model.

This study identified vocal and performance problems that elite vocal performers are attributing to age-related changes and what they are currently doing about such changes. This leads us to the next study, a randomized clinical trial examining the efficacy of VFEs, as a treatment modality for the normal aging voice.

CHAPTER 5: VOCAL FUNCTION EXERCISES AS A TREATMENT MODALITY FOR PRESBYPHONIA – A RANDOMIZED CONTROL TRIAL

Overview

Chapter 5 describes the third component of the dissertation, a randomized control trial examining the efficacy of voice therapy exercises for presbylaryngeus. As previously discussed, vocal quality and function can be negatively affected by changes to the vocal mechanism due to aging. Components one and two of the dissertation examined the need for a definition of the exceptional voice, expanded clinical consideration for optimal treatment and identified the aging vocal and performance related changes that exceptional singers were experiencing. These changes are chronic and can cause significant voice-related work and quality of life issues. Now that we have identified the problem, the question arises regarding the most efficacious treatment method for the aging voice. At present, voice therapy is an accepted treatment modality for the aging voice, specifically, Vocal Function Exercises (VFEs). Yet, we have identified that singers have voices that are exceptional and may not fit criteria of the typical aging voice.

To date, there has been no randomized control trial to explore the efficacy of VFEs on the normal aging voice to see how the normal aging larynx responds to vocal rehabilitation. We had a unique opportunity to study non-treatment individuals who were identified in a previous study as presenting with presbylaryngeus. Consequently, this group of participants could be used in a randomized clinical trial with an experimental/control design. This chapter will report unexpected and unique findings associated with this group of non-treatment seeking adults with presbylaryngeus.

Background

According to the population estimates from the United States Census Bureau, there are 50.8 million people age 65 years and over in the U.S out of the total population of 325 million or 15.62 percent. This population group continues to grow rapidly, up from 31.2 million in 1990 and 35 million in 2000. This growth trajectory of the 65 years and over population is currently outpacing the rate of the total population. Additionally, it is estimated that the number or adults 65 years and older will reach 98 million by 2060.[104] Voice problems are common and continue to increase in the aging population.[2-4] Approximately 29 percent of non-institutionalized adults 65 years and older report a current voice disorder[5] with approximately 25% of these individuals seeking specialized care for a voice disorder.[8] Presbyphonia, or aging voice, can negatively affect vocal function and quality of life in the aging population. Voice production requires a relative balance among three subsystems: respiration, phonation, and resonance. Perturbations within one of the subsystems can result in compensation of the other two subsystems, subsequently disrupting the entire system.[25] All three subsystems of voice are affected by aging changes that contribute to presbyphonia. This deterioration of voice is recognized as a part of the normal aging process[24,26,32,34-36,70] However, the ability to communicate through effective voice production across the lifespan is vital to maintaining independence, social interaction, psychological well-being, as well as ensuring quality of life[108,111,248] Aging changes in the larynx include neurogenic and structural changes. The typical glottal closure for presbylaryngeus is a spindle shaped closure or vocal fold bowing. Aging changes affect all three subsystems of voicing and result in the perceptual voice changes such as changes to pitch, loudness, pitch range, and voice quality.

As previously discussed, patients with presbylaryngeus have three treatment options related to vocal fold atrophy: surgical intervention, behavioral therapy, and a combination of the two. Individuals may also not recognize, care about, or know that treatment is available for aging vocal changes and therefore never seek treatment. The most common surgical option is an injection laryngoplasty. Another treatment alternative is voice therapy. This behavioral treatment modality for presbylaryngeus focuses on improving vocal function, with the outcome often measured as improved quality of life. Research has shown that voice therapy for presbylaryngeus, particularly for patients who show greater adherence to the voice therapy protocol, showed significant improvement after treatment.[109] Typically, voice therapy for presbylaryngeus focuses on increasing glottic closure and rebalancing the three subsystems of voice production.[25,109,123]

Vocal Function Exercises are a type of physiologic voice therapy. They comprise a series of voice manipulations designed to strengthen and balance the laryngeal muscles leading to an enhanced relationship of respiration, phonation, and resonance, thus improving vocal efficiency and voice quality.[169] They are used therapeutically to help improve glottic closure and rebalance the vocal mechanism. There are currently 29 outcomes studies demonstrating the efficacy of Vocal Function Exercises as a treatment outcome in multiple populations.[109,119,120,149,153,159,169-192] These studies have demonstrated VFEs to be effective in enhancing both normal and pathological voices. In the disordered population, VFEs have been found to rebalance laryngeal musculature, improving both vocal hyper- and hypofunction and have been used in combination with other treatment approaches to maximize patient outcomes. Eight studies have examined the efficacy of VFEs with the presbylaryngeus population.[109,119,172,174,182,185,187,194] These studies found statistically significant improvements of measures in all five domains of the voice assessment. These data suggest that VFEs can be used as a behavioral intervention to successfully treat age-related vocal changes.

Oates[249] reviewed ten studies published since 2008 to determine the effectiveness of behavioral intervention for presbylaryngeus. Multiple therapy techniques were used, including Vocal Function Exercises, phonation resistance training exercise, Lessac-Madsen resonant voice therapy, Lee Silverman[TM] voice treatment, neuromuscular electrical stimulation, semi-occluded vocal tract exercises, and flow phonation. Findings suggested that behavioral intervention for adults with presbylaryngeus have the potential to reverse the effects of normal vocal aging. However, the overall evidence was weak. Of note, out of the ten studies reviewed, none included an experimental control group. Oates recommended further research using stronger research design including the use of ASP intervention, clear selection criteria, comprehensive voice outcome measures, and the use of intervention methods that have a strong rationale built on an understanding of the physiological mechanism of vocal impairment rather than assumptions. Additionally, detailed treatment methods and schedules, including follow-up, were recommended to allow for replication and clinical application.

In a study similar to the current research, Sauder et al.[250] employed a prospective single-group pre-post descriptive study to examine a multi-dimensional assessment of treatment outcomes using VFEs for presbylaryngeus. Nine treatment-seeking participants with presbylaryngeus, ranging from 67-90 years of age completed a six-week course of voice therapy using VFEs with pre and post-treatment assessments performed. Results demonstrated that all participants reported post-treatment improvement in voice as assessed by the Voice Handicap Index (VHI)[142] and self-assessed voice severity and phonatory effort. No measurable improvements were observed with perceptual or selected acoustic measures and stroboscopic observations of vocal fold movement. This study did not include a control group, take advantage of aerodynamic measures, include a longer-term follow-up assessment or use high-speed videoendoscopy to enhance visual-perceptual observations. High-speed videoendoscopy differs from stroboscopy as it captures actual cycle-to-cycle vibratory motion of the vocal folds regardless of whether the signal is periodic or aperiodic, which is a significant advantage over stroboscopy.[251,252] Using a multidimensional assessment of voice across the five domains (visual imaging, acoustic, aerodynamic, patient subjective, and auditory-perceptual) helps to overcome the limitations of using a sole assessment measure.[253,254]

Specific Aims

The study had two specific aims.

Specific Aim 1: To examine the efficacy of Vocal Function Exercises for enhancing the voice production in individuals diagnosed with presbylaryngeus.

Specific Aim 2: To compare vocal function in individuals who have been treated with traditional voice therapy via VFEs (Exercise A) to controls (Exercise B) who receive an active speech protocol as determined by visual imaging (high-speed and stroboscopic), acoustic, aerodynamic, acoustic-perceptual, and patient subjective measures.

It was hypothesized that the Exercise A group will show significant improvement post-treatment in all five domains of voice assessment (patient self-assessment, audio-perceptual evaluation, acoustic and aerodynamic measures, and visual imaging of the vocal folds). It was further hypothesized that there will be no significant differences in the pre and post-treatment measures for the Exercise B group.

Methods

Participants for this study were recruited from previous research participants of the University of Kentucky Laryngeal Speech & Dynamics Lab and through word of mouth and flyers following approval from the Institutional Review Board (IRB) at the University of Kentucky (UK). A sample size of 20, with 10 participants in each group was required to achieve 80% power to detect a difference in MPT between experimental and control participants at a significance level of 0.10. This study design was a randomized control trial where Exercise A group received VFEs and Exercise B group received intervention featuring an active speech protocol that require no more effort than conversational speech. Data on each of the assessment parameters was collected pre-treatment, at the end of treatment, and at a one-month follow-up

Participants

Twenty-four individuals with presbylaryngeus were recruited for the study and randomly assigned to either Exercise A or Exercise B group, after informed consent was obtained. All participants were evaluated at the University of Kentucky Laryngeal and

Speech Dynamics Lab. Inclusion criteria included a diagnosis of presbylaryngeus, age 60 years and over, non-smokers, cognitively intact (as judged by the Mini-Cog screening), and ability to commit to the study timeframe. Exclusion criteria included neurologic voice disorder, head & neck cancer, vocal fold paralysis, laryngeal mass or lesion present, dementia, hearing loss that impedes treatment, previous treatment for presbylaryngeus, and inability to tolerate a rigid videostroboscopic examination of the vocal folds.

Subject Recruitment Methods and Privacy

Participants who were previously identified as having presbylaryngeus by researchers in a different study at the University of Kentucky Laryngeal Speech and Dynamic Lab and who expressed interest in participating in other research projects were contacted for this study. Participants who completed the study received a small payment approved by the IRB. Additional participants were recruited through word of mouth and IRB approved recruitment flyers. A coded participant list and data forms identified only by numeric code were stored in locked filing cabinet in the research lab. Four participants were not able to complete the study. One participant became ill and was not able to perform the exercises as required due to voice loss and three participants who were recruited through flyers did not meet inclusion criteria during the stroboscopic examination

Research Procedures

The following procedures were performed at the assessments of each participant. The assessment protocol included measures from all five domains of voice assessment (visual-perceptual, acoustic, aerodynamic, patient subjective, and auditory-perceptual). The checklists for the assessment protocol are available in Appendices XV-XVI. Outcome measures used for this study with their normative values are provided in **Table 5.1**.

Table 5.1 – Five domains of voice assessment with selected measures and normative values

Assessment Domain	Tool	Measures	Normative Values
Auditory Perceptual	Consensus Auditory Perpetual Evaluation of Voice (CAPE-V)	Overall severity, roughness, breathiness, strain, pitch, loudness (Measured on a 100mm visual analog scale)	< 10 for each parameter and overall severity
Subjective	Voice Handicap Index (VHI) Phonatory Effort Scale Vocal Severity Scale	Total score, physical, emotional, functional Overall score Overall score	<10 on each domain <30 for total score 0 – normal 0 - normal
Acoustic	KayPentax® Computerized Speech Laboratory	Jitter (%) Shimer (dB) Noise-to-harmonic ratio (NHR) Pitch Range Maximum Phonation Time (MPT) CSID /a/ CSID – Easy onset (EO) CSID – All Voiced (AV) CSID – Hard glottal attack (HGA) CSID – Voiceless plosive sentence (VP)	Jitter <1% Shimmer <0.35 dB NHR < 0.194 Pitch range: variable MPT: variable (dependent on individual lung capacity -VC) CSID /a/ -4.5-14 CSID EO -10.85 – 21.08 CSID AV -12.4 – 14.4 CSID HGA -8 – 19.6 CSID VP - -0.6 – 29.2
Aerodynamic	KayPentax® Phonatory Aerodynamic System	Mean airflow rate (L/s) Mean Peak Pressure Laryngeal Airway resistance (LAR) (cm H20/L/s) Phonation threshold pressure (PTP) (cm H20) Vital Capacity (VC)	Airflow rate: 0.08 - 0.2 L/s MPeak: 5 - 8 cm H20 LAR: 30 – 60 cm H20/L/s PTP: 3 – 5 cm H20 VC: 1500ML-4000ML
Visual Perceptual	Laryngeal stroboscopy and High speed laryngeal imaging	Glottic closure (GC) Mucosal wave (MW) Phase Symmetry (PS) Glottic Closure # (GC#) Overall appearance (Class)	GC: (0 = no gap, 1= anterior gap, 2= posterior gap, 3= spindle shaped gap) MW: (1= normal, 2 = slightly reduced, 3= mod to sev reduced) PS: (1 = symmetrical, 2 = slightly asymmetrical, 3 = mod to sev asymmetrical) GC#: (0= no gap, 1= small gap, 2= large gap) Class: not presby/presby

The assessment parameters with specific outcome measures are listed below as they pertain to this study.

Pre-Protocol Screening - All participants were screened using the Mini-Cog (Appendix VI), a brief screening test of cognitive performance with proven psychometric properties.[255] The participants must score at least three points to proceed with the protocol. All participants met the inclusion criteria.

Patient Subjective Measures – All participants completed the Voice Handicap Index (VHI – Appendix VIII) at each assessment. The VHI is a statistically robust instrument designed to assess the self-perceived psychosocial consequences of voice disorders.[142] The VHI is a self-administered questionnaire of 30 statements that evaluate a patient's judgement regarding the relative impact of his or her voice disorder on daily activities. The participant rates each statement, indicating how frequently they experience the event in question (0 = none, 4 = always). The VHI generates a total score and three sub scores (Functional, Physical, and Emotional). The VHI is scored 0-120 with 0 being no perceived disability and 120 being maximum perceived disability. The VHI has been psychometrically validated with strong internal consistency, reliability, test-retest stability, construct validity and was found to be sensitive to a wide array of voice disorders. The authors recommend that the VHI can be used as a measure of the effectiveness of specific treatment techniques as well as a component of functional outcome measures.[142] In addition to the VHI, participants were asked to self-assess their level of phonatory effort while reading the Rainbow Passage, a phonetically balanced reading passage.[256] Phonatory effort (Appendix IX) was rated on a scale from 0 to 3 with 0 = no effort, 1 = minimal effort, 2 = moderate effort, and 3 = maximal effort. Participants also judged vocal severity (Appendix IX) on a scale of 0 = normal, 1 = mild, 2 = moderate, and 3 = severe. All scores were included for the final analysis.

Auditory-Perceptual Analysis - Perceptual assessment was completed using the Consensus Auditory Perceptual Evaluation - Voice (CAPE-V – Appendix X).[257,258] Subjects were rated on overall voice quality, breathiness, roughness, strain, pitch and loudness on a 100 mm Visual Analog Scale. Audio samples of the participant's voices reading the rainbow passage (Appendix XI) were presented to licensed and certified speech-language pathologists with over 40 combined years of clinical experience in the field of voice disorder who each completed a CAPE-V on all assessment samples. The assessors were blinded to group assignments and the samples were randomized for analysis and were not presented as matched pairs. Pre and post-treatment recorded and de-identified audio samples of the Rainbow Passage, sustained /a/ and CAPE-V sentences were presented to the assessors and rated as presbylaryngeus or not- presbylaryngeus.

Aerodynamic Measures – The KayPentax Phonatory Aerodynamic System (PAS) was used to collect the following aerodynamic measures: vital capacity (VC), mean airflow rate (MAirflow), mean peak pressure (MPeak), Laryngeal airway resistance (LAR), and phonation threshold pressure (PTP).

Acoustic Measures – The KayPentax Multidimensional Voice Profile (MDVP), Realtime Pitch, and Analysis of Dysphonia in Speech and Voice (ADSV) were utilized. Specific outcome measures collected include maximum phonation time (MPT), pitch range, noise to harmonic ratio (NHR), jitter, shimmer, fundamental frequency (f_0) for MDVP and Real time pitch. Cepstral Spectral Index of Dysphonia (CSID) was utilized for ADSV with the following stimuli: sustained /a/, and sentence stimuli (easy onset, voiceless plosive, all voice and hard glottal attack).

Visual-Perceptual Measures - Multiple vocal fold parameters were collected using both laryngeal stroboscopy and high-speed laryngeal imaging. Parameters included glottic closure rating, glottic closure, mucosal wave, symmetry and overall classification. Glottic closure rating was judged as 0 = no gap, 1 = small gap, and 2 = large gap. The gaps were further judged under glottic closure classification as either an anterior gap, posterior gap, or spindle shaped gap. Mucosal wave was judged as normal, slightly reduced, or moderately to severely reduced. Symmetry was judged as symmetrical, slightly asymmetrical, or moderately to severely asymmetrical. Classifications were presbylaryngeus or not presbylaryngeus. Ratings were performed by the same voice expert SLPs who were blinded to group assignment using Appendix XII (Vocal Fold Parameters Ratings). The exams were presented in a randomized order.

Instrumentation

Laryngeal Stroboscopy: A licensed speech-language pathologist specializing in voice disorders performed a laryngeal exam to assess laryngeal function. Visual imaging of the appearance and vibratory characteristics of the vocal folds was performed using a laryngeal videostroboscopy system (Kay PENTAX Rhino-Laryngeal Strobscope – Model RLS 9100B, Halogen lamp: 150 watts, Xenon lamp: 120 watts, frequency range 60 Hz – 1000 Hz, laryngeal microphone) coupled to a 70-degree rigid scope (Kay-PENTAX, Model 9106, total length: 252 mm), Kay distal endoscope, and a C-mount camera (Panasonic 3 CCHD). The rigid endoscope was placed in the subject's mouth and rests on the tongue. A recording was made of the vibrating vocal folds phonation of the vowel /i/ with the various assessment protocol tasks.

High Speed Digital Imaging: For the HSDI video recordings, the black & white high-speed video system (Kay-PENTAX, Model 9710) with a 70-degree rigid scope (Kay-PENTAX, model SN 9106) was used with a 300-watt Xenon light source. Images were recorded at 4000 frames per second for a maximum duration of 4 seconds with a spatial resolution of 5123256 pixels.

Acoustic Analysis: Real-time acoustic data were digitized and recorded using the Kay-PENTAX CSL (Model 4500) Real-Time Pitch (Model 5121), Analysis of Dysphonia in Speech and Voice (ADSV), and Multi-Dimensional Voice Program (MDVP, Model 5105) applications. A directional microphone was placed at a known and constant distance from the subject's mouth (mouth-to-microphone distance = 3 inches) to transduce the voice tasks. [System Requirements: Analog Inputs: 4 channels: two XLR and two phono-type, 5mV to 10.5V peak-to-peak, adjustable gain range >38dB, 24-bit A/D, Sampling Rates: 8,000-200,000Hz, THD+N: <-90dB F.S. Frequency Response (AC coupled): 20-22kHz +.05dB at 44.1kHz. Digital Interface: AES/EBU or S/P DIF format, transformer-coupled. Software Interface: ASIO and MME. Computer Interface: PCI (version 2.2-compliant), PCI card; 5.0" H x 7.4" W x 0.75" D (half-sized PCI card). Analog Output: 4 channels, line and speaker, headphone output, channels 1 & 2 provide line & speaker outputs. Physical: 4" W x 8.25" H x 12.5" D, 4 lbs. 12 oz., 45 watts, speaker, and microphone (Shure SM-48 or equivalent, XLR-type)]. Digital audio recordings were taken at all assessments using the CSL to obtain a 5 second /a/, pitch range, the Rainbow Passage, and the ADSV protocol. Acoustical analysis was performed obtaining fundamental frequency, pitch range, maximum phonation time, jitter, shimmer, noise-to-harmonic ratio, and ADSV measures of dysphonia, including sustained vowel, rainbow passage, all-voiced sentence, hard glottal attack sentence, easy onset sentence, and voiceless plosives sentence.

Aerodynamic Analysis: Real-time aerodynamic data was digitized and analyzed with the Kay-PENTAX Phonatory Aerodynamic System (PAS) Model 6600 (300 ml pneumotachograph) System requirements are the same as CSL model 4500 listed above. A flexible silicon mask was placed over the nose and mouth so that no air can escape except through the mask's central port. A small flexible tube was inserted through the mask and positioned in the subject's mouth just behind the lips and in front of the teeth. This tube senses the pressure increase during voicing. The mask was also equipped with a screen calibrated to a known resistance that measures the airflow released from the mouth. The participant performed the aerodynamic tasks with the mask in place. Together, these transducers collected measures of intra-oral pressure and airflow during the speech activities collecting the measures of mean peak air pressure, mean airflow during voicing, and aerodynamic resistance. The tube was removed to perform an airflow volume task.

Intervention

Experimental: Exercise A group received voice therapy featuring VFEs (Appendix XV) that were performed two times each, twice a day. VFEs are a physiologic voice therapy program of four systematic exercises that are designed to strengthen and balance the laryngeal musculature, improve vocal fold adduction, balance airflow to the larynx, while rebalancing the three subsystems of voice production.[25] VFEs consist of the following exercises that are performed twice daily (morning and evening) with two trials each.

Exercise 1: *Warm-up exercise* – sustain the vowel /i/ as long as possible

- This is to be performed with extreme forward focus; "almost, but not quite nasal" as softly as possible.

Goal: Sustained /i/ equal to vital capacity/80mL/s (physiologic goal)

The maximum phonation time (MPT) goal for VFEs is based on a calculation that assumes that efficient voice production has a flow rate of 80-200 liters/second. An airflow rate below 80 L/sec would be limited airflow through the system and a rate above 200 L/sec would be excessive airflow through the system. (vital capacity/80mL/s = physiologic MPT goal of XX). For a patient with presbylaryngeus who is not a singer, we would consider meeting 80% of this goal sufficient for meeting vocal demands in all areas of daily life (MPT goal of XX *.80 = therapy discharge goal).

Exercise 2: *Ascending Glide* – stretching exercise – glide upward from lowest to highest note on the word "knoll"

- Extreme forward placement, open pharynx, and sympathetic lip vibration (transoral lip "buzz")
- Continue the stretch even after phonation has stopped

Goal: No voice breaks

Exercise 3: *Descending Glide* – contracting exercise – glide downward from highest to lowest note on the word "knoll:

- Extreme forward placement, open pharynx, and sympathetic lip vibration (transoral lip "buzz")
- Open pharynx, slow, no growl at the bottom, no muscling of the tone

Goal: No voice breaks

Exercise 4: *Low-impact Adductory Power Exercise* – sustain the musical notes C-D-E-F-G for as long as possible on the word "knoll" without the "kn"

- Open pharynx, lip vibration (transoral lip "buzz")

Goal: Sustained /i/ equal to vital capacity/80mL/s (physiologic goal)

All exercises are performed with a forward tone focus and a decreased loudness level. This helps ensure that the exercises are being completed with vocal technique that minimizes further injury and maximizes laryngeal benefit.

Control: Exercise B group (control) received the following active speech protocol exercises: (Appendix XVI)

1. Read a short passage using your comfortable conversation pitch.
2. Chant the sentences in group 1. (Plosives)
    a. Keep the book in your backpack.
    b. Take the bread to the ducks.
    c. The baby is playing peek-a-boo.
    d. Go pack the blue car.
    e. Time is quickly ticking away.
3. Chant the sentences in group 2. (Fricatives)
    a. The fairy placed a flower in the vase.
    b. There is a very fine view from the roof.
    c. The five verses were easy.

d. The vacant room was dark.

e. The rose was free of thorns.

4. Chant the sentences in group 3. (Sibilants)

    a. I eat cherries and cheese.

    b. Sissy sees the sun in the sky.

    c. She saw a sheep and a goose at the zoo.

    d. Did you see me leave my shoes by the hose?

    e. Sherry went shopping.

5. Chant the sentences in group 4. (Nasals)

    a. My mother made lemon jam.

    b. Marty is mad at Nancy.

    c. Neither Mary nor Mona ran.

    d. Mark will be marrying Pam.

    e. The merry man wore green.

Both groups performed all exercises two times each, twice a day for six weeks, and received handouts of the exercises for home practice sessions. Data from each practice session for both groups was recorded by the participants on a data log (Appendices XV-XVI) that was provided at the initial therapy session. Both groups completed the exercises as directed and logged individual attempt times. All exercises were taught by a certified and licensed speech-language pathologist (SLP) with expertise in voice therapy to ensure ideal training. Each participant received six weekly face-to-face therapy session conducted by the same SLP to facilitate appropriate technique, motivation and continued compliance.

Statistical Analysis

Demographic characteristics are presented as mean ± SD for continuous variables or count (percentage of participants) for categorical variables, with the differences between the treatment groups being assessed using 2-tailed Student's t-test or Fisher's exact test. For each outcome, the pre-measures were compared to the post-measures to see if there is any improvement, and the post-measures were compared to the 1-month measures to see if there was any regression after the month. The change data from pre-measures to post-measures and from post-measures to 1-month measures were then compared respectively between VFE and ASP. For continuous outcomes, these comparisons were made by creating general linear models where least squares means and their 95% confidence intervals of the change data are estimated. General linear models were also created with age and gender added in the model as covariates. Results from the general linear models with age and gender being covariates were similar to those with no covariates (data not shown). For ordinal outcomes, the change data were analyzed by Wilcoxon signed rank test, and Wilcoxon rank sum tests (with exact p-values computed due to the small sample size) were applied to assess group differences in the change data. All the tests were two-sided. To better understand the data, the continuous outcomes were illustrated by plotting their mean values with the associated standard errors across the pre, post, and 1-month time points stratified by treatment group.

Since this was an exploratory study, no adjustments for multiple comparisons were made and significance was set at p=0.10. All statistical analyses were performed with SAS software (version 9.4; SAS Institute, Cary, NC).

Results

After informed consent was obtained, a total of 24 participants were recruited for the study. Four participants were excluded from final analysis. One participant had a severe upper respiratory infection in the middle of his exercise intervention to the point where he was unable to perform exercises for large amounts of time. Three other participants were excluded during the initial evaluation due to not meeting inclusion criteria during the stroboscopic examination. Data from the remaining 20 participants were included for the final analysis.

The mean age in the VFE group (n=10) was 73.6 years (SD: 5.2) and the mean age in the ASP group (n=10) was 69 years (SD: 6.7). All participants in both groups had a diagnosis of presbylaryngeus. The VFE group was comprised of 7 male and 3 female participants and the ASP group was comprised of 3 males and 7 females. Patient demographics stratified by treatment are available in **Table 5.2**.

Table 5.2 - Participant demographics stratified by treatment (n = 20)

	ASP (n=10)	VFE (n=10)	
Males	3	7	
Females	7	3	
			p-value
Age (years), mean ± SD (Range 62-83)	69.0 ± 6.7	73.6 ± 5.2	0.10[a]
Female, n (%)	7 (70)	3 (30)	0.18[b]

[a] From two-sample t-test.
[b] From Fisher's exact test.

As previously stated, participants in each group were assessed with the full assessment battery at the following three points: initial, post-therapy (6 weeks), and a one-month follow-up. Participants in both groups (VFE & ASP) underwent voice therapy in person for 6 weekly sessions. In addition, the VFE group also received VFE exercises on a digital audio file for home practice. The number of sessions attended by each participant was 100% and is presented in **Table 5.3**. Both groups were assigned select activities (VFE or ASP exercises) to be performed twice a day. All participants included in the study results were able to complete all study points. All participants filled out data logs (Appendix XV - XVII) to monitor home practice compliance. The maximum amount of missed home practice sessions was 11/84 equaling 13% of total home practice time due to seasonal allergies. Most participants missed 0-3 home practices. **Table 5.3** provides data on exercises compliance providing the total number and percent of home practice sessions missed by each participant.

Table 5.3 – Participant attendance and adherence to VFE & AS protocols

Participant	Percent of sessions attended	VFE Protocol twice a day	AS Protocol twice a day	Home practice sessions missed X/84 = %
3	100%	X		0
4	100%	X		0
5	100%	X		0
6	100%	X		1, 0.01%
8	100%		X	0
9	100%	X		3, 0.035%
10	100%		X	2, 0.02%
11	100%		X	3, 0.035%
13	100%		X	4, 0.047%
14	100%	X		11, 0.13%
15	100%	X		9, 0.107%
16	100%		X	1, 0.01%
17	100%		X	1, 0.01%
18	100%	X		0
19	100%	X		4, 0.047%
20	100%	X		0
21	100%		X	0
22	100%		X	0
23	100%		X	0
24	100%		X	3, 0.035%

The next section will present the statistical and descriptive results for all five domains of the voice assessment (subjective, auditory-perceptual, acoustic, aerodynamic, visual imaging).

Subjective Measures

Voice Handicap Index (VHI) –

Overall, an increase in total VHI score was seen in both groups directly following the six weeks of intervention with six participants in each group (12/20) scoring higher (worse) on the VHI total. Four participants in each group decreased in total VHI following intervention. At the one-month assessment, nine participants in the VFE group decreased in total VHI score compared to baseline and one participant scored the same as their baseline. In the ASP group, 3 participants increased total VHI following the one-month assessment, 5 participants decreased and 2 remained the same as their baseline score. This data is reflected in **Table 5.4** – VHI group analysis – descriptive.

Table 5.4 – VHI group analysis - descriptive

VFE	Post-Tx	One Month	**ASP**	Post-Tx	One Month
3	+1	0	*8*	-28	-28
4	+6	-2	*10*	+26	+24
5	+3	-2	*11*	+16	-3
6	+12	-2	*13*	+7	0
9	-1	-8	*16*	-6	-10
14	+2	-2	*17*	0	0
15	+3	-2	*21*	+4	+2
18	-3	-10	*22*	-10	-10
19	-7	-6	*23*	+7	+1
20	-19	-19	*24*	+3	-2

Pre and post VHI measures from general linear model analysis were not statistically significant for any of the VHI score components for either group. (**Tables 5.5 and 5.6**)

Table 5.5 - VHI findings and group comparisons: Pre vs. post*

	LS Mean (95% CI) of Change from Pre to Post		Group Difference in Change from Pre to Post	
	ASP (n=10)	VFE (n=10)	LS Mean (95% CI)	p-value
VHI				
VHI Total Score	1.90 (-6.02, 9.82)	-0.30 (-8.22, 7.62)	-2.20 (-13.41, 9.01)	0.68
VHI-Physical	1.90 (-1.13, 4.93)	0.50 (-2.53, 3.53)	-1.40 (-5.68, 2.88)	0.50
VHI-Functional	-0.80 (-3.85, 2.25)	-0.20 (-3.25, 2.85)	0.60 (-3.71, 4.91)	0.77
VHI-Emotional	0.70 (-1.76, 3.16)	-0.30 (-2.76, 2.16)	-1.00 (-4.47, 2.47)	0.55

*General linear models.

Table 5.6 - VHI findings and group comparisons: post vs. 1-month*

	LS Mean (95% CI) of Change from Post to 1-Month		Group Difference in Change from Post to 1-Month	
	ASP (n=10)	VFE (n=10)	LS Mean (95% CI)	p-value
VHI				
VHI Total Score	-4.50 (-7.94, -1.06)	-4.60 (-8.04, -1.16)	-0.10 (-4.97, 4.77)	0.97
VHI-Physical	-2.00 (-4.21, 0.21)	-2.40 (-4.61, -0.19)	-0.40 (-3.52, 2.72)	0.79
VHI-Functional	-1.70 (-3.07, -0.33)	-1.70 (-3.07, -0.33)	0 (-1.93, 1.93)	1.00
VHI-Emotional	-0.70 (-1.54, 0.14)	-0.50 (-1.34, 0.34)	0.20 (-0.98, 1.38)	0.73

*General linear models.

Phonatory Effort –

In the VFE group, eight participants reported no change in phonatory effort and two participants reported decreased phonatory effort following six weeks of voice therapy. At the one-month follow-up, five participants reported decreased phonatory effort, four reported no change compared to baseline, and one person reported increased phonatory effort. In the ASP group, five participants reported no change in phonatory effort, four participants reported increased phonatory effort and one reported decreased phonatory effort after intervention. At the one-month follow-up, phonatory effort results for the ASP group were the same as the post-intervention results. Phonatory effort group analysis descriptive data is reflected in **Table 5.7.**

Table 5.7 – Phonatory effort group analysis - descriptive

VFE	Post Therapy	One-month	**ASP**	Post Therapy	One-month
3	0	-1	*8*	+1	+1
4	0	-1	*10*	0	0
5	0	+1	*11*	0	0
6	0	0	*13*	+1	0
9	0	0	*16*	-1	-1
14	0	0	*17*	0	+1
15	-1	-1	*21*	0	0
18	-1	-1	*22*	+2	+2
19	0	-1	*23*	0	0
20	0	0	*24*	+1	+1

0 = no effort, 1 = minimal effort, 2 = moderate effort, 3 = severe effort

Phonatory effort findings using a Wilcoxon signed rank test and Wilcoxon rank sum tests were not significant at either the pre to post therapy comparison or the post to one-month comparison (**Table 5.8** and **5.9**).

Table 5.8 – Phonatory effort findings and group comparisons: pre vs. post*

	Change from Pre to Post*				p-value for Test of Group Difference**
	ASP (n=10)		VFE (n=10)		
	Median (IQR)	p-value	Median (IQR)	p-value	
Phonatory effort	0.0 (0.0, 1.0)	0.63	0.0 (0.0, 0.0)	0.50	0.23

*Wilcoxon signed rank test exact test. IQR, interquartile range.
** Wilcoxon rank sum test.

Table 5.9 – Phonatory effort findings and group comparisons: post vs. 1-month*

	Change from Post to 1-Month*				p-value for Test of Group Difference**
	ASP (n=10)		VFE (n=10)		
	Median (IQR)	p-value	Median (IQR)	p-value	
Phonatory effort	0.0 (0.0, 0.0)	0.75	0.0 (-1.0, 0.0)	0.63	0.29

*Wilcoxon signed rank test exact test. IQR, interquartile range.
** Wilcoxon rank sum test.

Vocal Severity –

Overall, 12 of the 20 participants reported no change in vocal severity compared to baseline at the post-intervention assessment and 13 out of 20 reported no change compared to baseline at the one-month assessment. In the VFE group, five participants reported no change in vocal severity, four reported a decrease in vocal severity, and one participant reported an increase in vocal severity at the post-therapy assessment. At the one-month assessment, seven participants reported no change from baseline in vocal severity and three participants reported a decrease from baseline in vocal severity. Seven participants in the ASP group reported no change from baseline in vocal severity measures, two reported increased vocal severity and one participant reported a decrease. At the one-month assessment, six participants reported no change from baseline, three participants reported an increase in vocal severity, and one participant reported a decrease in vocal severity compared to baseline measures. This data is reflected in **Table 5.10**.

Table 5.10 – Vocal severity group analysis – descriptive

VFE	Post Therapy	One-month	**ASP**	Post Therapy	One-month
3	0	0	*8*	0	+1
4	0	0	*10*	0	0
5	-1	0	*11*	0	0
6	-1	-1	*13*	+1	0
9	0	0	*16*	-1	-1
14	-1	-1	*17*	0	+1
15	-1	-1	*21*	0	0
18	0	0	*22*	+1	+1
19	+1	0	*23*	0	0
20	0	0	*24*	0	0

0 = normal, 1 = mild, 2 = moderate, 3 = severe

Vocal severity findings using a Wilcoxon signed rank test and Wilcoxon rank sum tests were not significant for either comparison (pre to post-therapy or post therapy to one-month). This data is shown in **Tables 5.11** and **5.12**.

Table 5.11 - Vocal severity findings and group comparisons: pre vs. post*

	Change from Pre to Post*				p-value for Test of Group Difference**
	ASP (n=10)		VFE (n=10)		
	Median (IQR)	p-value	Median (IQR)	p-value	
Vocal severity	0.0 (0.0, 0.0)	1.00	0.0 (-1.0, 0.0)	0.38	0.34

*Wilcoxon signed rank test exact test. IQR, interquartile range.
** Wilcoxon rank sum test.

Table 5.12 - Vocal severity findings and group comparisons: post vs. 1-month*

	Change from Post to 1-Month*				p-value for Test of Group Difference**
	ASP (n=10)		VFE (n=10)		
	Median (IQR)	p-value	Median (IQR)	p-value	
Vocal severity	0.0 (0.0, 1.0)	0.63	0.0 (0.0, 0.0)	1.00	0.29

*Wilcoxon signed rank test exact test. IQR, interquartile range.
** Wilcoxon rank sum test.

Auditory Perceptual Measures

The descriptive results of the CAPE-V auditory perceptual analysis do not provide significant results. In the overall category, with the VFE group, two participants initially scored with abnormal scores. At the post-therapy assessment, five of the participants decreased compared to their initial score and three increased in total score. At the one-month assessment, five participants were decreased in overall category compared to the initial assessment and three participants were increased. In the ASP group, seven participants were decreased and one participant were increased at the post-therapy assessment and eight were decreased and one increased at the one-month assessment compared to their initial scores (**Table 5.13**).

Table 5.13: CAPE-V overall group analysis - descriptive

VFE	Pre	Post	1-month	**ASP**	Pre	Post	1-month
3	14	3	4	*8*	7	3	6
4	16	4	9	*10*	6	9	5
5	6	10	9	*11*	7	3	3
6	9	4	3	*13*	3	3	2
9	3	3	14	*16*	3	2	7
14	1	2	2	*17*	7	3	3
15	9	0	0	*21*	2	2	1
18	2	1	1	*22*	2	1	3
19	2	2	2	*23*	6	3	3
20	2	3	2	*24*	3	2	2
Mean, SD	6.4, ±5.39	3.2, ±2.69	4.6, ±4.5		4.6, ±2.17	3.1, 2.13	3.5, ±4.5

In the roughness category of the CAPE-V, two participants in the VFE group had abnormal roughness scores of 24 and 21. Both of these participants had decreased to normal at the post-therapy assessment and maintained this at the one-month assessment. There was no clinical change in the ASP group (**Table 5.14**).

Table 5.14: CAPE-V roughness group analysis - descriptive

VFE	Pre	Post	1-month	**ASP**	Pre	Post	1-month
3	24	0	3	*8*	3	2	5
4	21	4	7	*10*	5	4	4
5	5	6	7	*11*	4	2	3
6	5	3	3	*13*	2	2	1
9	3	3	13	*16*	2	2	6
14	0	2	2	*17*	6	2	2
15	0	0	0	*21*	3	1	1
18	1	0	2	*22*	1	1	2
19	3	2	2	*23*	3	1	2
20	2	2	2	*24*	2	0	1
Mean, SD	6.4, ±8.6	2.2, ±1.93	4.1, ±3.8		3.1, ±1.52	1.7, 1.05	2.7, ±1.76

The VFE group had one participant who scored an abnormal breathiness score on the CAPE-V at the initial assessment. This dropped to 0 at post-therapy assessment and was maintained at the one-month follow-up. There was no notable clinical change in the ASP group (**Table 5.15**).

Table 5.15: CAPE-V breathiness group analysis - descriptive

VFE	Pre	Post	1-month	**ASP**	Pre	Post	1-month
3	3	0	0	*8*	0	0	0
4	0	0	0	*10*	0	0	0
5	0	0	0	*11*	0	0	0
6	0	0	0	*13*	0	0	0
9	1	0	0	*16*	1	1	0
14	0	0	0	*17*	0	0	0
15	11	0	0	*21*	0	0	0
18	0	0	1	*22*	0	0	2
19	0	0	0	*23*	0	0	0
20	0	0	0	*24*	1	0	0
Mean, SD	1.5, ±3.47	0, ±0	0.1, ±0.31		0.2, ±0.42	0.1, ±0.31	0.2, ±0.42

In the CAPE-V category of strain, there were two participants of the VFE group score abnormally at the initial assessment. Both of these decreased to normal values at the post-therapy assessment and maintained this at the one-month assessment. There was no notable clinical change in the ASP group (**Table 5.16**).

Table 5.16: CAPE-V strain group analysis - descriptive

VFE	Pre	Post	1-month	**ASP**	Pre	Post	1-month
3	5	0	0	*8*	3	2	3
4	19	3	4	*10*	2	3	4
5	0	0	4	*11*	1	2	2
6	3	0	1	*13*	2	1	1
9	5	3	5	*16*	2	1	2
14	0	0	0	*17*	2	1	4
15	19	4	5	*21*	2	0	0
18	6	0	1	*22*	1	0	2
19	1	1	0	*23*	4	2	2
20	0	0	0	*24*	2	0	1
Mean, SD	4.9, ±5.93	1.1, ±1.59	2, ±2.21		2.1, ±0.87	1.2, ±1.03	2.1, ± 1.28

The CAPE-V category of pitch revealed two participants who decreased in pitch scores at the post-therapy assessment with a minimal increase at the one-month assessment. The ASP group values remained almost constant at all assessment points (**Table 5.17**).

Table 5.17: CAPE-V pitch group analysis - descriptive

VFE	Pre	Post	1-month	**ASP**	Pre	Post	1-month
3	5	0	2	*8*	2	2	2
4	7	0	3	*10*	2	6	2
5	3	3	4	*11*	2	2	3
6	3	2	1	*13*	5	2	3
9	0	0	9	*16*	2	2	2
14	0	0	0	*17*	2	1	1
15	0	0	0	*21*	0	0	0
18	0	0	1	*22*	1	0	2
19	0	0	0	*23*	3	1	2
20	0	1	0	*24*	0	2	1
Mean, SD	1.8, ±2.57	0.6, ± 1.07	2, ± 2.82		1.9, ±1.44	1.8, ± 1.68	1.8, ± 0.91

The final category of the CAPE-V, loudness, had one participant of the VFE group scoring an abnormal (22) value at the initial assessment. This was decreased to 0 at the post-therapy assessment and maintained with a minimal increase at the one-month assessment. Two other members of the VFE group had borderline high (9) scored that also decreased at the post-therapy and one-month assessments. No clinically notable change was observed in the ASP group for loudness.

Table 5.18: CAPE-V loudness group analysis - descriptive

VFE	Pre	Post	1-month	**ASP**	Pre	Post	1-month
3	22	0	2	*8*	2	1	0
4	9	3	4	*10*	0	0	1
5	9	0	0	*11*	1	4	2
6	3	0	0	*13*	2	0	0
9	1	0	3	*16*	1	0	1
14	0	0	0	*17*	1	0	1
15	0	0	0	*21*	0	0	0
18	0	0	2	*22*	1	3	4
19	0	1	0	*23*	1	0	0
20	0	0	0	*24*	1	2	2
Mean, SD	4.4, ±7.16	0.4, ±0.96	1.1, ± 1.52		1, ± 0.66	1, ± 1.49	1.1, ± 1.28

Pre and post CAPE-V measures from general linear model analysis of the initial assessment compared to the post-therapy assessment were statistically significant for loudness with p = 0.10. The other CAPE-V categories of overall, roughness, breathiness, strain, and pitch were not significant (**Table 5.19**).

Table 5.19: CAPE-V findings and group comparisons: pre vs. post*

	LS Mean (95% CI) of Change from Pre to Post		Group Difference in Change from Pre to Post	
	ASP (n=10)	VFE (n=10)	LS Mean (95% CI)	p-value
CAPE-V				
CAPE-V overall	-1.50 (-4.36, 1.36)	-3.20 (-6.06, -0.34)	-1.70 (-5.75, 2.35)	0.39
CAPE-V roughness	-1.40 (-5.58, 2.78)	-4.20 (-8.38, -0.02)	-2.80 (-8.72, 3.12)	0.33
CAPE-V breathiness	-0.10 (-1.74, 1.54)	-1.50 (-3.14, 0.14)	-1.40 (-3.72, 0.92)	0.22
CAPE-V strain	-0.90 (-3.29, 1.49)	-3.80 (-6.19, -1.41)	-2.90 (-6.28, 0.48)	0.09
CAPE-V pitch	-0.10 (-1.64, 1.44)	-1.20 (-2.74, 0.34)	-1.10 (-3.28, 1.08)	0.30
CAPE-V loudness	0 (-3.41, 3.41)	-4.00 (-7.41, -0.59)	-4.00 (-8.82, 0.82)	**0.10****

*General linear models.
** Indicates significance at p=0.1

Pre and post CAPE-V measures from general linear model analysis of the post-therapy assessment compared to the one-month assessment were not statistically significant for any of the categories (overall, roughness, breathiness, strain, pitch, and loudness). The data is reflected in **Table 5.20.**

Table 5.20: CAPE-V findings and group comparisons: post vs. 1-month

	LS Mean (95% CI) of Change from Post to 1-Month		Group Difference in Change from Post to 1-Month	
	ASP (n=10)	VFE (n=10)	LS Mean (95% CI)	p-value
CAPE-V				
CAPE-V overall	0.40 (-1.73, 2.53)	1.40 (-0.73, 3.53)	1.00 (-2.01, 4.01)	0.49
CAPE-V roughness	1.00 (-0.62, 2.62)	1.90 (0.28, 3.52)	0.90 (-1.39, 3.19)	0.42
CAPE-V breathiness	0.10 (-0.28, 0.48)	0.10 (-0.28, 0.48)	0 (-0.53, 0.53)	1.00
CAPE-V strain	0.90 (0.10, 1.70)	0.90 (0.10, 1.70)	0 (-1.12, 1.12)	1.00
CAPE-V pitch	0 (-1.58, 1.58)	1.40 (-0.18, 2.98)	1.40 (-0.84, 3.64)	0.21
CAPE-V loudness	0.10 (-0.64, 0.85)	0.70 (-0.05, 1.45)	0.60 (-0.46, 1.66)	0.25

*General linear models.

Acoustic Measures

The assessment domain of acoustic analysis includes the following measures: f_0, jitter, shimmer, NHR, MPT, pitch range, and the CSID values of /a/, EOS, VPS, AVS, and HGAS. The following section contains the statistical analysis of these measures beginning with descriptive statistics.

For the descriptive analysis of f_0, group members were further assessed as men vs. women since men typically increase in f_0 with age while women typically decrease. In the VFE group, four of the seven men had decreased f_0 at the post-therapy assessment with two women measuring slightly increased f_0. The men and one of the women lost their gains at the one-month assessment while one woman did maintain her pitch increase. In the ASP group, there was no change in the men at the post therapy assessment however, two women had further decline and one woman increased in pitch. At the one-month assessment, five women measured increased f_0 and two decreased with two of the men measuring increased f_0 at the one-month assessment. This data is shown in **Table 5.21**.

Table 5.21: Acoustic - f_0 group analysis - descriptive

VFE	Pre	Post	1-month	**ASP**	Pre	Post	1-month
3	195.095	146.55	175.892	*8*	157.47	159.72	149.01
4	183.66	188.82	172.72	*10*	174.15	175.72	185.246
5	167.87	173.503	169.84	*11*	160.799	163.02	168.2
6	163.337	152.33	172.79	*13*	170.339	175.51	180
9	149.55	147.37	157.902	*16*	180.384	180.7	187.55
14	168.123	150.9	161	*17*	149.31	148.56	175.01
15	137.064	145.88	153.97	*21*	206.33	196.078	189.86
18	150.31	150.8	138.41	*22*	191.965	178.57	196.015
19	207.15	209.56	199.052	*23*	153.62	165.54	163.29
20	156.15	159.331	162.93	*24*	199.842	189.32	185.95

There was decline seen in the acoustic measure of jitter in the VFE group: four participants had increased jitter levels at the initial assessment with five participants increased at the post-therapy assessment. This dropped to two participants with increased jitter levels at the one-month assessment. In the ASP group, three participants had increased jitter levels at the initial assessment, increasing to seven at the post-therapy assessment and four participants at the one-month assessment (**Table 5.22**).

Table 5.22: Acoustic – jitter group analysis - descriptive

VFE	Pre	Post	1-month	**ASP**	Pre	Post	1-month
3	1.2	0.413	0.454	*8*	0.595	2.917	1.242
4	1.872	1.337	0.97	*10*	1.086	2.13	0.97
5	4.038	1.62	1.939	*11*	2.258	1.47	2.49
6	0.726	0.84	0.395	*13*	0.418	2.485	0.369
9	0.782	0.672	0.88	*16*	0.908	0.905	0.632
14	0.539	0.98	0.477	*17*	0.983	0.513	0.44
15	0.478	0.49	0.458	*21*	2.807	2.336	0.978
18	0.904	1.444	0.871	*22*	0.826	0.55	0.838
19	0.422	1.067	1.116	*23*	0.912	1.61	2.187
20	2.556	1.129	0.641	*24*	0.953	1.019	2.797

Shimmer measures for the VFE group found 5 participants with increased shimmer at the initial assessment. All VFE participants had normal shimmer levels at the post-therapy assessment and three participants declined to abnormal values at the one-month assessment. In the ASP group, four participants had increased shimmer values at the initial assessment. This increased to six participants with abnormal values at the post-therapy assessment and declined to four participants in the abnormal range at the one-month assessment. This data is reflected in **Table 5.23**.

Table 5.23: Acoustic – shimmer group analysis - descriptive

VFE	Pre	Post	1-month	**ASP**	Pre	Post	1-month
3	0.172	0.24	0.204	*8*	0.452	0.698	0.484
4	0.41	0.304	0.532	*10*	0.393	0.695	0.534
5	1.126	0.153	0.189	*11*	0.338	0.34	0.366
6	0.389	0.348	0.216	*13*	0.308	0.413	0.273
9	0.663	0.339	0.384	*16*	0.192	0.251	0.25
14	0.203	0.45	0.261	*17*	0.363	0.352	0.305
15	0.304	0.382	0.3	*21*	0.284	0.187	0.22
18	0.515	0.383	0.347	*22*	0.12	0.159	0.183
19	0.218	0.125	0.282	*23*	0.214	0.432	0.197
20	0.259	0.279	0.293	*24*	0.455	0.412	0.453

One participant of the VFE group had increased NHR at baseline. It was within normal limits at the post-therapy and one-month assessments. No participants in the ASP group had elevated NHR values at any point. (**Table 5.24**).

Table 5.24: Acoustic – NHR group analysis - descriptive

VFE	Pre	Post	1-month	**ASP**	Pre	Post	1-month
3	0.069	0.143	0.135	*8*	0.131	0.13	0.159
4	0.135	0.136	0.11	*10*	0.121	0.17	0.132
5	0.24	0.103	0.15	*11*	0.149	0.122	0.119
6	0.184	0.15	0.145	*13*	0.136	0.151	0.124
9	0.153	0.153	0.149	*16*	0.106	0.104	0.131
14	0.147	0.149	0.132	*17*	0.143	0.125	0.135
15	0.121	0.13	0.144	*21*	0.115	0.129	0.094
18	0.121	0.156	0.154	*22*	0.147	0.108	0.086
19	0.12	0.114	0.134	*23*	0.127	0.117	0.129
20	0.147	0.124	0.132	*24*	0.147	0.153	0.139

MPT was increased compared to the initial assessment in eight of the participants at the post-therapy assessment. This measure was analyzed for maintenance by comparing the one-month value to the post-therapy value. Three of the VFE participants maintained their increase at the one-month mark while seven declined. Eight of the VFE group members still had a higher MPT at the one-month follow up than they did at the initial assessment. In the ASP group, four participants increased at the post-therapy assessment while six members decreased. At the one-month mark, three participants had increased MPT while seven decreased. Two of the ASP participants had improved MPT compared to baseline at the one-month assessment while eight participants had decreased MPT compared to baseline values. This data is shown in **Table 5.25**.

Table 5.25: Acoustic – MPT group analysis - descriptive

VFE	Pre	Post	1-month	**ASP**	Pre	Post	1-month
3	28.17	29.78+	21.93-	*8*	11.6	14.03+	12.65-
4	28.96	29.76+	29.53-	*10*	10.7	8.67-	9.38+
5	22.66	13.86-	25.71+	*11*	15.21	16.07+	15.36-
6	19.85	17.34-	25.05+	*13*	16.24	15.93-	14.65-
9	22.22	24.13+	22.66-	*16*	16.67	19.43+	11.7-
14	11.14	24.5+	20.27-	*17*	17.9	12.68-	16.71+
15	25.32	28.14+	24.79-	*21*	23.04	15.49-	20.67+
18	9.48	13.63+	11.71-	*22*	16.7	13.37-	12.97-
19	29.19	29.53+	29.65+	*23*	29.5	20.29-	17.78-
20	18.2	23.91+	21.11-	*24*	18.49	24.68+	22.09-

+ increase in MPT
- decrease in MPT

For the CSID /a/ analysis, the VFE group had three participants with increased /a/ values at the initial assessment. Those three improved to normal values by the post-therapy assessment while one participant had a worse /a/ value at this point. There was only one increased /a/ value at the one-month assessment. In the ASP group there were four increased /a/ at the initial assessment and six at the post-therapy assessment. This decreased to two increased CSID /a/ values in the ASP group at the one-month assessment (Table 5.26).

Table 5.26: Acoustic – CSID /a/ group analysis - descriptive

VFE	Pre	Post	1-month	**ASP**	Pre	Post	1-month
3	18.194	-3.601	12.75	*8*	0.51	20.849	4.904
4	11.705	13.405	6.83	*10*	15.06	29.93	8.38
5	35.508	3.979	12.427	*11*	16.808	22.22	9.318
6	8.661	12.671	6.324	*13*	7.624	16.71	0.807
9	18.467	11.98	16.38	*16*	4.856	-3.97	1.16
14	1.129	10.956	7.691	*17*	17.45	17.67	-3.33
15	3.213	2.814	7.308	*21*	10.098	2.239	14.83
18	4.433	11.686	2.259	*22*	-3.812	-12.859	-2.27
19	-4.24	5.5	4.999	*23*	45.15	21.855	6.67
20	10.13	21.245	10.37	*24*	5.827	12.26	17.868

The VFE group had two participants with increased CSID easy onset (EO) sentence values at the initial assessment. This decreased to one at the post-therapy assessment and rose to two at the one-month assessment. In the ASP group, three participants had increased EO measures at the initial assessment, two at the post-therapy assessment and one-month assessment. This data is reflected in Table **5.27**.

Table 5.27: Acoustic – CSID EO group analysis - descriptive

VFE	Pre	Post	1-month	**ASP**	Pre	Post	1-month
3	19.603	2.64	12.35	*8*	2.994	0.918	0.776
4	16.138	10.54	9.879	*10*	21.355	19.8	15.01
5	11.341	28.14	21.26	*11*	14.403	21.61	6.387
6	25.75	6.11	21.75	*13*	14.63	-2.978	3.56
9	4.34	0.338	-0.333	*16*	12.285	11.36	2.824
14	-2.163	-0.506	-18.289	*17*	26.79	1.719	4.317
15	-15.817	-7.6	-15.916	*21*	11.64	-0.187	14.858
18	5.171	-6.43	-1.233	*22*	40.97	30.61	15.32
19	28.58	16.86	2.477	*23*	13.14	13.533	27.088
20	3.53	16.386	7.523	*24*	2.145	4.193	22.12

CSID analysis of the voiceless plosive (VP) sentences found one different participant in the VFE group with increased values at each of the initial, post-therapy, and one-month assessments. The ASP group had a participant at both of the initial and post-therapy assessments with increased measures (**Table 5.28**).

Table 5.28: Acoustic – CSID VP group analysis - descriptive

VFE	Pre	Post	1-month	**ASP**	Pre	Post	1-month
3	18.293	5.158	35.881	*8*	15.98	21.042	9.73
4	30.332	16.378	-10.289	*10*	37.018	13.78	14.17
5	24.168	31.39	14.35	*11*	7.166	13.02	4.283
6	20.38	11.51	16.65	*13*	23.53	27.81	22.14
9	3.244	9.861	13.457	*16*	9.07	8.224	16.338
14	2.964	8.256	3.977	*17*	31.48	35.15	21.25
15	-10.509	4.558	9.756	*21*	-14.216	15.365	23.51
18	18.25	13.643	-10.79	*22*	28.788	32.284	19.891
19	-12.14	23.51	14.837	*23*	27.16	24.27	28.57
20	-3.34	30.682	21.1	*24*	24.348	13.648	24.04

None of the participants in the VFE group had increased values for the CSID hard glottal attack (HGA) sentence measure at the initial analysis. There were two participants with increased values at the post-therapy assessment and one at the one-month assessment. In the ASP group two participants had increased values at the initial assessment, increasing to three at the post-therapy assessment and two at the one-month assessment. This data is shown in **Table 5.29**.

Table 5.29: Acoustic – CSID HGA group analysis - descriptive

VFE	Pre	Post	1-month	**ASP**	Pre	Post	1-month
3	12.624	10.47	4.586	*8*	4.515	1.907	6.951
4	8.956	16.24	13.83	*10*	9.832	1.401	-6.67
5	18.096	23.42	25.529	*11*	2.677	20.01	9.953
6	-3.102	28.96	10.988	*13*	13.093	9.86	4.829
9	0.774	-4.9	13.318	*16*	-1.134	6.12	2.669
14	-3.058	-19.09	-30.91	*17*	48.25	36.43	41.84
15	9.088	13.057	12.975	*21*	-14.21	-14.091	4.821
18	-12.62	0.818	-2.56	*22*	36.704	39.951	12.012
19	11.43	2.467	4.898	*23*	9.77	5.92	19.16
20	7.53	16.01	11.455	*24*	18.63	11.34	18.79

The final acoustic measure, CSID all voiced (AV) sentences had no increased values at in the VFE group at the initial assessment, two participants increased at the post-therapy assessment and one increased at the one-month assessment. In the ASP group there were three participants with increased values at the initial assessment with 0 at the post-therapy and one-month assessment (**Table 5.30**).

Table 5.30: Acoustic – CSID AV group analysis - descriptive

VFE	Pre	Post	1-month	**ASP**	Pre	Post	1-month
3	-12.357	1.94	7.88	*8*	6.342	6.01	12.82
4	-1.137	-4.946	-9.972	*10*	3.012	5.879	2.675
5	0.67	33.13	10.22	*11*	10.584	13.12	8.76
6	8.293	-8.714	5.91	*13*	5.47	5.47	5.07
9	7.814	7.767	15.24	*16*	16.58	4.21	-3.619
14	-22.68	-6.983	-5.548	*17*	15.12	13.622	12.24
15	-10.414	-1.787	-6.523	*21*	-2.119	-9.173	1.995
18	9.218	-4.7	16.335	*22*	20.125	4.769	3.42
19	-4.349	16.86	-7.313	*23*	7.29	11.58	6.34
20	-11.79	-6.542	-12.42	*24*	7.94	-14.204	7.464

In the VFE group, seven participants had increased ascending range (1-11 semitones (ST)), one had no change, and one participant decreased by one ST compared to the initial assessment at the post-therapy assessment. At the one-month assessment, six participants maintained their increased range of (1-13 ST), one had no change compared to baseline, and three participants had decreased range of 1-4 ST compared to their baseline measure. In the ASP group, five participants had a small increased range of 1-2 ST, one participant had no change and four measured a decreased upper range of 3-6 ST. At the one-month assessment, four of the ASP participants had increased ascending ranges of 2-4 ST, one participant had no change and six had a decreased upper range of 1-4 ST. This data is reflected in **Table 5.31**.

Table 5.31: Ascending range by group – change in semitone (st) - descriptive

VFE	Post Therapy	One-month	**ASP**	Post Therapy	One-month
3	+5	+1	*8*	+2	+4
4	+4	+3	*10*	-5	-2
5	-1	+1	*11*	+1	-1
6	+11	+9	*13*	-1	-1
9	-1	-1	*16*	+1	+4
14	+6	+13	*17*	0	+2
15	+5	+6	*21*	+2	-4
18	+1	-1	*22*	+1	0
19	+3	-4	*23*	-3	+2
20	0	0	*24*	-6	-3

In the VFE group, two participants had no change in their lower range following the intervention, five participants lost 1-4 ST and three participants reported increased lower ranges by 1-2 ST when compared to the initial assessment. At the one-month assessment, eight of the VFE participants lost 1-4 ST in their lower range and two participants gained 2-4 ST compared to their initial assessment. In the ASP group, two participants had no change in the lower range following the intervention, five participants lost 1-4 ST and three participants increased their lower range by 1-7 ST compared to baseline. At the one-month assessment, six participants lost 1-4 ST in the lower range, one had no change and three participants gained 1-6 ST compared to baseline. This data is shown in Table **5.32**.

Table 5.32: Descending range by group – change in semitones (st) - descriptive

VFE	Post Therapy	One-month	**ASP**	Post Therapy	One-month
3	-1	+2	*8*	+4	+4
4	+1	+4	*10*	+3	+1
5	-1	-4	*11*	-1	-1
6	-2	+1	*13*	-7	-6
9	0	+2	*16*	-1	+1
14	0	+2	*17*	+1	+1
15	+2	+1	*21*	+1	+2
18	+1	-1	*22*	0	-1
19	+2	+2	*23*	+1	+1
20	+4	+2	*24*	0	0

Pre and post acoustic measures from general linear model analysis of the initial assessment compared to the post- therapy assessment was statistically significant for shimmer (p = 0.08), ascending range (p = 0.01) and CSID AV (p = 0.06). The jitter measure was approaching significance at p = 0.11. The data is reflected in **Table 5.33.**

Table 5.33: Acoustic findings and group comparisons: pre vs. post*

	LS Mean (95% CI) of Change from Pre to Post		Group Difference in Change from Pre to Post	
	ASP (n=10)	VFE (n=10)	LS Mean (95% CI)	p-value
Acoustic measures				
F0	-1.15 (-10.02, 7.73)	-5.33 (-14.20, 3.55)	-4.18 (-16.73, 8.37)	0.49
Jitter	0.42 (-0.27, 1.10)	-0.35 (-1.04, 0.33)	-0.77 (-1.74, 0.20)	0.11
Shimmer	0.08 (-0.09, 0.25)	-0.13 (-0.29, 0.04)	-0.21 (-0.45, 0.03)	**0.08****
NHR	-0.001 (-0.03, 0.03)	-0.008 (-0.04, 0.02)	-0.007 (-0.05, 0.03)	0.73
MPT	-1.54 (-5.05, 1.97)	1.94 (-1.57, 5.45)	3.48 (-1.48, 8.44)	0.16
Pitch range low	-0.90 (-12.11, 10.31)	2.50 (-8.71, 13.71)	3.40 (-12.45, 19.25)	0.66
Pitch range high	-34.10 (-104.34, 36.14)	97.70 (27.46, 167.94)	131.80 (32.46, 231.14)	**0.01****
CSID /a/	0.73 (-8.42, 9.89)	-1.66 (-10.81, 7.50)	-2.39 (-15.34, 10.56)	0.70
CSID EO	-5.98 (-13.51, 1.55)	-3.00 (-10.53, 4.53)	2.98 (-7.67, 13.63)	0.56
CSID VP	-9.23 (-21.59, 3.12)	-0.06 (-12.42, 12.29)	9.17 (-8.30, 26.64)	0.28
CSID AV	-4.91 (-13.31, 3.50)	6.28 (-2.13, 14.68)	11.18 (-0.71, 23.07)	**0.06****
CSID HGA	-0.93 (-8.37, 6.52)	3.77 (-3.67, 11.22)	4.70 (-5.83, 15.23)	0.36

*General linear models.
** Indicates significance at p=0.1

Pre and post acoustic measures from general linear model analysis of the post-therapy assessment compared to the one-month assessment was not statistically significant for any of the acoustic measures at these time points. The data is shown in **Table 5.34.**

Table 5.34: Acoustic findings and group comparisons: post vs. 1-month*

	LS Mean (95% CI) of Change from Post to 1-Month		Group Difference in Change from Post to 1-Month	
	ASP (n=10)	VFE (n=10)	LS Mean (95% CI)	p-value
Acoustic measures				
F0	4.74 (-3.96, 13.44)	3.95 (-4.75, 12.64)	-0.79 (-13.09, 11.51)	0.89
Jitter	-0.30 (-0.91, 0.31)	-0.18 (-0.79, 0.43)	0.12 (-0.74, 0.99)	0.77
Shimmer	-0.07 (-0.15, 0.01)	0.005 (-0.08, 0.08)	0.07 (-0.04, 0.18)	0.21
NHR	-0.006 (-0.02, 0.01)	0.003 (-0.01, 0.02)	0.01 (-0.01, 0.03)	0.40
MPT	-0.67 (-3.88, 2.54)	-0.22 (-3.43, 2.99)	0.45 (-4.09, 4.99)	0.84
Pitch range low	0.70 (-6.98, 8.38)	2.90 (-4.78, 10.58)	2.20 (-8.66, 13.06)	0.68
Pitch range high	33.00 (-60.49, 126.49)	-17.00 (-110.49, 76.49)	-50.00 (-182.22, 82.22)	0.44
CSID /a/	-6.86 (-14.44, 0.73)	-0.33 (-7.92, 7.26)	6.53 (-4.20, 17.25)	0.22
CSID EO	1.17 (-6.41, 8.74)	-2.70 (-10.28, 4.88)	-3.87 (-14.58, 6.84)	0.46
CSID VP	8.59 (-1.67, 18.85)	1.79 (-8.47, 12.05)	-6.80 (-21.31, 7.71)	0.34
CSID AV	1.59 (-6.49, 9.67)	-1.22 (-9.30, 6.86)	-2.81 (-14.24, 8.62)	0.61
CSID HGA	-0.45 (-8.20, 7.30)	-2.33 (-10.08, 5.41)	-1.89 (-12.84, 9.07)	0.72

*General linear models.

Aerodynamic Measures

The assessment domain of aerodynamic analysis includes the following measures: vital capacity (VC), mean airflow rate during voicing (MAirflow), subglottic pressure (Psub), laryngeal airway resistance (LAR), and phonation threshold pressure (PTP). The following section contains the statistical analysis of these measures beginning with descriptive statistics.

For the descriptive analysis of VC, all VFE participants were within normal limits at the initial assessment. Five participants increased VC at the post-therapy assessment and five decreased compared to initial assessment. One participant of the VFE group had clinically low VC at the post-therapy assessment which improved at the one-month assessment. At the one-month assessment eight participants increased VC and two decreased compared to the post-therapy assessment. In the ASP group, two participants measured decreased VC at the initial assessment. Six participants had decreased VC, three were clinically low, at the post-therapy assessment and five participants had decreased VC at the one-month mark, two of which were clinically low, compared to the post-therapy assessment (**Table 5.35**).

Table 5.35: Aerodynamic – VC group analysis - descriptive

VFE	Pre	Post	1-month	**ASP**	Pre	Post	1-month
3	4.03	5.2+	4.52-	*8*	2	1.94-	1.9-
4	2.84	2.69-	2.72+	*10*	2.22	2.02-	2.06+
5	3.19	2.77-	2.9+	*11*	3.81	3.64-	2.56-
6	4.17	3.59-	4.33+	*13*	2.56	2.64+	2.77+
9	2.6	3.04+	3.24+	*16*	1.24	1.3+	1.77+
14	3.77	3.66-	4+	*17*	4.86	4.41-	5.61+
15	4.9	5.38+	5.04-	*21*	2.23	2.34+	2.25-
18	2.8	3.11+	3.26+	*22*	3.5	3.1-	2.31-
19	2.27	2.6+	2.25-	*23*	1.69	1.4-	2.14+
20	2.03	1.97-	3.51+	*24*	2.08	2.56+	2.28-

+ increased VC
- Decreased VC

In the VFE group for MAirflow, three participants had clinically decreased MAirflow and one had increased at the initial assessment. At the post-therapy assessment, three participants were decreased and one was increased. Two participants still had decreased MAirflow at the one-month assessment. In the ASP group, three participants had clinically decreased MAirflow at the initial assessment. At the post-therapy assessment, one participant had decreased MAirflow and one was increased. Four participants had decreased MAirflow and one had increased MAirflow and the one-month assessment. The data is reflected in **Table 5.36**.

Table 5.36: Aerodynamic – MAirflow group analysis – descriptive

VFE	Pre	Post	1-month	**ASP**	Pre	Post	1-month
3	0.21	0.11	0.11	*8*	0.07	0.13	0.09
4	0.07	0.04	0.07	*10*	0.09	0.16	0.14
5	0.12	0.12	0.15	*11*	0.03	0.11	0.06
6	0.18	0.17	0.1	*13*	0.13	0.12	0.17
9	0.07	0.06	0.05	*16*	0.09	0.12	0.06
14	0.13	0.13	0.08	*17*	0.15	0.18	0.23
15	0.13	0.16	0.11	*21*	0.08	0.09	0.09
18	0.2	0.26	0.2	*22*	0.16	0.26	0.21
19	0.18	0.09	0.09	*23*	0.05	0.03	0.06
20	0.09	0.07	0.09	*24*	0.13	0.13	0.02

The analysis of MPeak revealed six participants of the VFE group to have clinically abnormally (3 decreased, 3 increased) MPeak during the initial assessment. Eight of the participants had normal values at the post-therapy assessment while two participants continued to have mildly increased MPeak. At the one-month assessment one participant had decreased MPeak and one had increased MPeak compared clinical norms. In the ASP group, three participants had clinically increased values and three had clinically decreased values at the initial assessment. Three participants had increased values at the post-therapy assessment and the one-month assessment. This is reflected in **Table 5.37**.

Table 5.37: Aerodynamic – MPeak group analysis - descriptive

VFE	Pre	Post	1-month	**ASP**	Pre	Post	1-month
3	4.39	6.2	6.19	*8*	6.95	7.66	8.08
4	3.82	7.92	6.07	*10*	4.86	5.29	6.51
5	4.55	5.35	4.87	*11*	9.2	8.25	7.63
6	9.08	8.63	5.32	*13*	7.89	8.68	7.06
9	8.54	6.87	9.0	*16*	5.9	6.52	6.45
14	7.46	8.24	8.36	*17*	9.64	9.1	12.57
15	8.03	5.83	7.57	*21*	5.85	6.12	4.41
18	6.55	5.48	6.98	*22*	4.29	4.69	4.57
19	7.38	6.98	5.75	*23*	8.08	7.89	9.8
20	6.63	5.04	5.79	*24*	6.16	5.2	6.8

The analysis of the aerodynamic measure, ARes, found two participants in the VFE group to have clinically decreased ARes and one with increased at the initial assessment. At the post therapy assessment, three participants measured increased ARes and this increased to four at the one-month assessment. In the ASP group five participants had increased ARes at baseline and one participant was decreased. This declined to four participants with increased ARes and one with decreased at the post-therapy assessment with the same total but several different participants at the one-month assessment (**Table 5.38**).

Table 5.38: Aerodynamic – ARes group analysis - descriptive

VFE	Pre	Post	1-month	ASP	Pre	Post	1-month
3	20.32	54.09	52.08	*8*	100.96	56.72	82.77
4	53.63	52.98	119.47	*10*	50.52	30.59	44.72
5	34.97	42.46	30.57	*11*	147.12	70.26	126.19
6	45.98	46.97	51.89	*13*	56.63	69.24	39.29
9	122.46	105.09	136.32	*16*	63.88	52.87	97.44
14	54.48	62.12	102.43	*17*	59.45	47.54	54.79
15	57.04	35.42	63.92	*21*	67.96	63.19	47.88
18	30.54	20.06	32.56	*22*	25.33	17.3	17.6
19	39.51	75.1	62.7	*23*	163.85	299.95	166.58
20	11.56	63.21	59.05	*24*	44.77	39.56	112.79

The final aerodynamic measure of PTP found overall improvement in the VFE group with worsening after the intervention at the post-therapy assessment for the ASP group. In the VFE group, three participants had decreased PTP and one participant had increased PTP at baseline. One participant continued to have decreased PTP at the one-month assessment while two different participants measured increased PTP. At the one-month assessment point only one participant had a clinically abnormal value, a mildly increased PTP. In the ASP group four participants measured increased PTP at baseline and this increased to six at the post therapy assessment. Four of the 10 participants had increased PTP at the one-month assessment. The data is shown in **Table 5.39**.

Table 5.39: Aerodynamic – PTP group analysis - descriptive

VFE	Pre	Post	1-month	**ASP**	Pre	Post	1-month
3	0.56	4.13	4.32	*8*	1.84	3.45	4.4
4	2.77	3.61	4.03	*10*	4.43	2.71	3.65
5	3.34	6.3	5.25	*11*	2.96	6.73	5.83
6	3.89	6.62	3.21	*13*	5.55	7.48	4.61
9	6.5	3.64	4.88	*16*	6.55	5.9	1.48
14	5.63	4.17	4	*17*	7.34	7.21	9.37
15	5.69	5	4.44	*21*	3.44	5.95	4.39
18	6.41	5.01	4.83	*22*	3.97	5.74	1.37
19	5.45	5.44	3.47	*23*	5.69	4.42	6.52
20	2.07	2.57	3.38	*24*	7.5	3.54	6.84

Pre and post aerodynamic measures were analyzed using a general linear model analysis of the initial assessment compared to the post- therapy assessment. The results found that MAirflow was statistically significant with $p = 0.02$. The remaining measures of VC, MPeak, LAR and PTP were not found to be significant. The data is reflected in **Table 5.40.**

Table 5.40: Aerodynamic findings and group comparisons: pre vs. post*

	LS Mean (95% CI) of Change from Pre to Post		Group Difference in Change from Pre to Post	
	ASP (n=10)	VFE (n=10)	LS Mean (95% CI)	p-value
Aerodynamic measures				
VC	-0.08 (-0.36, 0.19)	0.14 (-0.13, 0.41)	0.23 (-0.16, 0.61)	0.24
MAirflow	0.04 (0.005, 0.06)	-0.02 (-0.05, 0.01)	-0.05 (-0.09, -0.01)	**0.02****
MPeak	0.06 (-0.90, 1.01)	0.01 (-0.94, 0.96)	-0.05 (-1.39, 1.30)	0.94
LAR	-23.33 (-72.33, 25.68)	8.70 (-40.30, 57.71)	32.03 (-37.28, 101.33)	0.34
PTP	0.39 (-1.84, 2.61)	-0.58 (-2.81, 1.64)	-0.97 (-4.12, 2.18)	0.53

*General linear models.
** Indicates significance at p=0.1

Pre and post acoustic measures from general linear model analysis of the post-therapy assessment compared to the one-month assessment was not statistically significant for any of the aerodynamic measures at these time points. The data is shown in **Table 5.41.**

Table 5.41: Aerodynamic findings and group comparisons: post vs. 1-month*

	LS Mean (95% CI) of Change from Post to 1-Month		Group Difference in Change from Post to 1-Month	
	ASP (n=10)	VFE (n=10)	LS Mean (95% CI)	p-value
Aerodynamic measures				
VC	0.03 (-0.41, 0.46)	0.18 (-0.26, 0.61)	0.15 (-0.46, 0.76)	0.62
MAirflow	-0.02 (-1.18, 1.14)	0.76 (-0.40, 1.92)	0.78 (-0.86, 2.42)	0.33
MPeak	0.45 (-1.31, 2.21)	-1.56 (-3.31, 0.20)	-2.00 (-4.49, 0.48)	0.11
LAR	24.28 (-25.16, 73.73)	15.35 (-34.10, 64.79)	-8.93 (-78.86, 60.99)	0.79
PTP	-0.47 (-2.54, 1.60)	0.53 (-1.54, 2.60)	1.00 (-1.93, 3.93)	0.48

*General linear models.

Visual Perceptual Measures - Stroboscopic Imaging

Visual-perceptual domains assessment include the following measures: glottic closure, glottic closure classification, mucosal wave (MW), phase symmetry (symmetry), and overall classification. The following sections contains the statistical analysis of these measures for both stroboscopic and high-speed imaging beginning with descriptive statistics.

For the descriptive analysis of glottic closure, overall, improvement was seen in the VFE group post therapy and at the one-month mark and no improvement was noted in the ASP group at any point. For further descriptive analysis, seven of the ten VFE participants were rated to have a small gap, one participant had a large glottal gap, and two did not present with a gap at baseline. This improved to six participants with no gap at the post-therapy assessment. In the ASP group, eight participants had a small gap at baseline and two had a large gap. At the post therapy assessment three participants had a large gap and seven had a small gap. This dropped slightly to two participants with a large gap at the one-month assessment with the other eight participants judged as having a small gap. This data is shown below in **Table 5.42**.

Table 5.42: Stroboscopic imaging– closure group analysis - descriptive

VFE	Pre	Post	1-month	**ASP**	Pre	Post	1-month
3	1	0	1	*8*	1	2	1
4	1	0	1	*10*	1	1	1
5	1	0	1	*11*	1	1	1
6	1	1	1	*13*	1	1	1
9	1	0	0	*16*	1	1	1
14	1	1	1	*17*	2	2	2
15	0	0	0	*21*	1	1	1
18	1	1	1	*22*	2	2	2
19	2	0	1	*23*	1	1	1
20	0	1	0	*24*	1	1	1

0 = no gap, 1 = small gap, 2 = large gap

The next assessment measure for stroboscopic imaging is glottic closure classification. In the VFE group six participants were judged to have an anterior gap at baseline, one had a posterior gap and one had a spindle shaped gap. At the post therapy assessment, six participants were judged to have no gap compared to just two at the baseline. One participant had a continued posterior gap at the post therapy and one-month assessments. The improvement did not remain at the one-month assessment where six participants had an anterior gap, one had a posterior gap and three were judged to have no gap. Overall, no significant improvement was seen in the ASP group. At baseline, six participants had an anterior gap, 2 had a posterior gap and two had a spindle shaped gap. At the post therapy assessment six participants had an anterior gap, one had an anterior gap, and three had spindle shaped gaps. Eight participants continued to have an anterior gap at the one-month assessment with one participant each having a posterior and spindle shaped gaps (**Table 5.43**).

Table 5.43: Stroboscopic imaging– glottic closure classification group analysis - descriptive

VFE	Pre	Post	1-month	**ASP**	Pre	Post	1-month
3	1	0	1	*8*	1	1	1
4	1	0	1	*10*	2	2	2
5	1	0	1	*11*	1	1	1
6	1	1	1	*13*	2	1	1
9	1	0	0	*16*	1	1	3
14	1	1	1	*17*	1	3	1
15	0	0	0	*21*	3	3	1
18	2	2	2	*22*	1	3	1
19	3	0	1	*23*	3	1	1
20	0	1	0	*24*	1	1	1

0 = no gap, 1 = anterior gap, 2 = posterior gap, 3 = spindle shaped gap

In the VFE group, MW was judged to be normal in seven participants, with 2 participants judged as mildly reduced and one participant with moderately to severely reduced MW at baseline and again at the post-therapy assessment. At the one-month assessment, there were six participants judged as normal, three with a mildly reduced MW and one with a moderately to severely reduced MW. The ASP group had five participants with normal MW at baseline and four with mildly reduced MW and one with moderately to severely reduced MW. At the one-month assessment, six participants were judged to be within normal parameters with four participants judged as having a mildly reduced MW (**Table 5.44**).

Table 5.44: Stroboscopic imaging – MW group analysis - descriptive

VFE	Pre	Post	1-month	**ASP**	Pre	Post	1-month
3	1	1	1	*8*	1	1	1
4	1	1	1	*10*	1	1	1
5	1	1	1	*11*	1	1	1
6	1	1	1	*13*	2	1	1
9	1	1	1	*16*	1	1	2
14	3	3	3	*17*	1	1	1
15	2	2	2	*21*	2	2	1
18	2	2	2	*22*	2	2	2
19	1	1	1	*23*	3	2	2
20	1	1	2	*24*	2	2	2

1 = normal, 2 = mildly reduced, 3 = moderately to severely reduced

The descriptive analysis of stroboscopic symmetry revealed five participants judged as normal and five judged as having slight asymmetry at baseline in the VFE group. This improved to nine with normal symmetry and one participant with slight asymmetry at the post therapy assessment. Overall, gains were kept with seven participants judged as having normal symmetry and three with slight asymmetry at the one-month assessment. In the ASP group, seven participants were judged to have normal symmetry and three participants with slight asymmetry at baseline. At the post therapy assessment, four were judged to have mild asymmetry and six were found to have normal symmetry. This improved at the one-month assessment with eight participants having normal symmetry and two judged to have slight asymmetry. This data is shown in **Table 5.45**.

Table 5.45: Stroboscopic imaging– symmetry group analysis - descriptive

VFE	Pre	Post	1-month	**ASP**	Pre	Post	1-month
3	1	1	2	*8*	1	2	1
4	1	1	1	*10*	2	2	2
5	2	1	1	*11*	2	1	1
6	1	1	1	*13*	1	1	1
9	2	2	2	*16*	1	2	2
14	1	1	1	*17*	1	1	1
15	2	1	1	*21*	1	2	1
18	1	1	1	*22*	2	1	1
19	2	1	1	*23*	1	1	1
20	2	1	2	*24*	1	1	1

1 = symmetrical, 2 = slightly asymmetrical, 3 = moderately to severely asymmetrical

Overall, all participants in both groups (VFE and ASP) were judged to be presbylaryngeus at the initial assessment. For the VFE group, this improved to five participants with presbylaryngeus and five judged as normal at the post-therapy assessment. Those gains were not maintained at the one-month assessment where nine participants were judged to be presbylaryngeus with one participant judged as normal. In the ASP group all participants were judged to be presbylaryngeus at each data point (initial, post-therapy, and one month). This data is reflected in **Table 5.46**.

Table 5.46: Stroboscopic imaging– classification group analysis - descriptive

VFE	Pre	Post	1-month	**ASP**	Pre	Post	1-month
3	1	0	1	*8*	1	1	1
4	1	0	1	*10*	1	1	1
5	1	0	1	*11*	1	1	1
6	1	1	1	*13*	1	1	1
9	1	0	0	*16*	1	1	1
14	1	1	1	*17*	1	1	1
15	1	1	1	*21*	1	1	1
18	1	1	1	*22*	1	1	1
19	1	0	1	*23*	1	1	1
20	1	1	1	*24*	1	1	1

0 = not presbylaryngeus, 1 = presbylaryngeus

Pre- and post-therapy stroboscopic measures analysis using a Wilcoxon signed rank test exact test and Wilcoxon rank sum test compared to initial assessment to the post-therapy assessment. The following measures were found to be significant: glottic closure (p = 0.03), symmetry (p = 0.10), and classification (p = 0.03). The other stroboscopic categories of glottal closure classification and mucosal wave were not significant (**Table 5.47**).]

Table 5.47 - Stroboscopic imaging parameters and group comparisons: pre vs. post*

	Change from Pre to Post*				p-value for Test of Group Difference**
	ASP (n=10)		VFE (n=10)		
	Median (IQR)	p-value	Median (IQR)	p-value	
Strobe visual imaging					
Glottic closure	0.0 (0.0, 0.0)	1.00	-0.5 (-1.0, 0.0)	0.19	**0.03*** **
Glottic closure classification	0.0 (0.0, 0.0)	1.00	-0.5 (-1.0, 0.0)	0.19	0.21
Mucosal wave	0.0 (0.0, 0.0)	0.50	0.0 (0.0, 0.0)	1.00	1.00
Symmetry	0.0 (0.0, 1.0)	1.00	-0.5 (-1.0, 0.0)	0.06	**0.10*** **
Classification	0.0 (0.0, 0.0)	--	-0.5 (-1.0, 0.0)	0.06	**0.03*** **

*Wilcoxon signed rank test exact test. IQR, interquartile range.
** Wilcoxon rank sum test.
*** Indicates significance at p=0.1

Post-therapy and one-month assessment stroboscopic measures analysis using a Wilcoxon signed rank test exact test and Wilcoxon rank sum test compared to initial assessment to the post-therapy assessment. The following measures were found to be significant: glottic closure (p = 0.08), symmetry (p = 0.07), and classification (p = 0.09). The other stroboscopic categories of glottal closure classification and mucosal wave were not significant (**Table 5.48**).

Table 5.48 - Stroboscopic parameters and group comparisons: post vs. 1-month*

	Change from Post to 1-Month*				p-value for Test of Group Difference**
	ASP (n=10)		VFE (n=10)		
	Median (IQR)	p-value	Median (IQR)	p-value	
Strobe visual imaging					
Glottic closure	0.0 (0.0, 0.0)	1.00	0.0 (0.0, 1.0)	0.38	**0.08*****
Glottic closure classification	0.0 (-2.0, 0.0)	0.63	0.0 (0.0, 1.0)	0.38	0.16
Mucosal wave	0.0 (0.0, 0.0)	1.00	0.0 (0.0, 0.0)	0.50	0.63
Symmetry	0.0 (0.0, 0.0)	0.50	0.0 (0.0, 1.0)	0.25	**0.07*****
Classification	0.0 (0.0, 0.0)	--	0.0 (0.0, 1.0)	0.13	**0.09*****

*Wilcoxon signed rank test exact test. IQR, interquartile range.
** Wilcoxon rank sum test.
*** Indicates significance at p=0.1

Visual Perceptual –High-Speed Imaging

The final assessment parameters are in the visual perceptual domain using high-speed imaging. The data collected and categories are the same as for the stroboscopic imaging: glottic closure, glottic closure classification, mucosal wave (MW), phase symmetry (symmetry), and overall classification.

For glottic closure, in the VFE group, two participants were judged to have no gap, seven had a small gap and one had a large gap at the initial assessment. At the post-therapy assessment six participants were found to have no gap with four still presenting with a small gap. This slightly declined to five participants judged as having no gap at the one-month assessment and five having a small gap. In the ASP group, seven participants were judged to have a small gap and three had a large gap at the initial assessment. Comparatively, six participants were judged to have a small gap at the post therapy assessment while four participants had large gaps. This distribution was the same for the ASP group at the one-month assessment point (**Table 5.49**).

Table 5.49: High-speed imaging– closure group analysis - descriptive

VFE	Pre	Post	1-month	**ASP**	Pre	Post	1-month
3	2	0	1	*8*	1	1	1
4	1	0	0	*10*	1	1	1
5	1	0	0	*11*	1	2	1
6	0	1	0	*13*	1	1	1
9	1	1	1	*16*	1	1	1
14	1	1	1	*17*	2	2	2
15	1	0	0	*21*	1	1	1
18	1	1	1	*22*	2	2	2
19	1	0	1	*23*	1	1	2
20	0	0	0	*24*	2	2	2

0 = no gap, 1 = small gap, 2 = large gap

Similar results were seen with the glottic closure classification group analysis. In the VFE group, two participants were judged to have no gap, three had an anterior gap, two had a posterior gap, and three had a spindle shaped gap at baseline. This improved to five participants with no gap, three with an anterior gap, and one with a posterior gap at the post therapy assessment. At the one-month assessment five participants were judged to have no gap, three had an anterior gap, one had a posterior gap, and one had a spindle shaped gap. In the ASP group, five participants had an anterior gap at baseline, one had a posterior gap and three had spindle shaped gaps. By the post therapy assessment, five participants were classified as having an anterior gap, one had a posterior gap and four had spindle shaped gaps. The same distribution was present at the one-month assessment. This data is reflected in **Table 5.50**.

Table 5.50: High-speed imaging– glottic closure classification group analysis - descriptive

VFE	Pre	Post	1-month	**ASP**	Pre	Post	1-month
3	3	0	1	*8*	1	1	1
4	1	0	0	*10*	2	2	2
5	2	0	0	*11*	1	3	1
6	0	1	0	*13*	1	1	1
9	1	1	1	*16*	1	1	3
14	1	1	1	*17*	3	3	1
15	3	0	0	*21*	1	3	1
18	2	2	2	*22*	3	3	3
19	3	0	3	*23*	3	1	3
20	0	0	0	*24*	3	1	3

0 = no gap, 1 = anterior gap, 2 = posterior gap, 3 = spindle shaped gap

For the descriptive analysis of MW, six participants in the VFE group were judged to have normal MW and four had mildly reduced MW. At the post therapy assessment this dropped to three with mildly reduced MW and seven with normal MW. The one-month assessment was the same distribution as the initial assessment. In the ASP group eight participants were judged to have normal MW at baseline with two mildly reduced MWs. No change was noted at the post therapy assessment. By the one-month assessment, six participants were judged to have normal MW with three mildly reduced and one moderately to severely reduced MW (**Table 5.51**).

Table 5.51: High-speed imaging – MW group analysis - descriptive

VFE	Pre	Post	1-month	**ASP**	Pre	Post	1-month
3	1	1	1	8	1	1	1
4	1	1	1	10	1	1	1
5	1	1	1	11	1	1	1
6	1	1	1	13	1	1	1
9	1	1	1	16	1	1	2
14	2	2	2	17	1	1	1
15	2	1	2	21	1	1	1
18	2	2	2	22	2	2	2
19	1	1	1	23	1	1	2
20	2	2	2	24	2	2	3

1 = normal, 2 = mildly reduced, 3 = moderately to severely reduced

For the category of symmetry, seven of the VFE groups were judged to have normal symmetry and three were slightly asymmetrical at baseline. This increased to four participants judged as slightly asymmetrical and six with normal symmetry at the post therapy assessment and decreased to eight with normal symmetry and two with slight asymmetry at the one-month assessment. In the ASP group there were seven participants with normal symmetry and three with slight asymmetry at the initial assessment. This worsened to five with normal symmetry, three with slight asymmetry and two with moderately to severe symmetry at the post therapy assessment. By the one-month assessment, six participants were judged to have slight asymmetry and four were still classified as normal (**Table 5.52**).

Table 5.52: High-speed imaging– symmetry group analysis - descriptive

VFE	Pre	Post	1-month	**ASP**	Pre	Post	1-month
3	1	1	1	8	1	1	1
4	1	1	1	10	2	3	2
5	1	1	1	11	2	3	2
6	1	1	1	13	2	2	2
9	2	2	1	16	1	1	2
14	1	2	1	17	1	1	1
15	1	2	1	21	1	2	1
18	1	1	1	22	1	1	2
19	2	1	2	23	1	1	1
20	2	2	2	24	1	2	2

1 = symmetrical, 2 = slightly asymmetrical, 3 = moderately to severely asymmetrical

In the final category of classification, all participants in both groups were judged to be presbylaryngeus at the initial evaluation. This decreased to five participants classified as presbylaryngeus and five as not presbylaryngeus at the post therapy assessment in the VFE group and four not presbylaryngeus and six presbylaryngeus at the one-month assessment. There was no change in the ASP group at any of the assessment points. This data is reflected in **Table 5.53**.

Table 5.53: High-speed imaging– classification group analysis - descriptive

VFE	Pre	Post	1-month	**ASP**	Pre	Post	1-month
3	1	0	1	8	1	1	1
4	1	0	0	10	1	1	1
5	1	0	0	11	1	1	1
6	1	1	0	13	1	1	1
9	1	1	1	16	1	1	1
14	1	1	1	17	1	1	1
15	1	0	0	21	1	1	1
18	1	1	1	22	1	1	1
19	1	0	1	23	1	1	1
20	1	1	1	24	1	1	1

0 = not presbylaryngeus, 1 = presbylaryngeus

A Wilcoxon signed rank exact test and Wilcoxon rank sum test was used for group comparisons for the initial assessment vs. the post therapy assessment. Significant findings were revealed in the glottic closure category (p = 0.03) and classification (p = 0.03). The remaining categories of glottic closure classification, mucosal wave and symmetry were not significant. This is shown in **Table 5.54**.

Table 5.54 - High-speed imaging parameters and group comparisons: pre vs. post*

	Change from Pre to Post*				p-value for Test of Group Difference**
	ASP (n=10)		VFE (n=10)		
	Median (IQR)	p-value	Median (IQR)	p-value	
High-speed visual imaging					
Glottic closure	0.0 (0.0, 0.0)	1.00	-0.5 (-1.0, 0.0)	0.19	**0.03*** **
Glottic closure classification	0.0 (0.0, 0.0)	1.00	-0.5 (-3.0, 0.0)	0.09	0.13
Mucosal wave	0.0 (0.0, 0.0)	--	0.0 (0.0, 0.0)	0.50	0.47
Symmetry	0.0 (0.0, 1.0)	0.13	0.0 (0.0, 0.0)	1.00	0.28
Classification	0.0 (0.0, 0.0)	--	-0.5 (-1.0, 0.0)	0.06	**0.03*** **

*Wilcoxon signed rank test exact test. IQR, interquartile range.
** Wilcoxon rank sum test.
*** Indicates significance at p=0.1

A Wilcoxon signed rank exact test and Wilcoxon rank sum test was also used for group comparisons for the post-therapy assessment vs. the one-month assessment to examine maintenance of gains. None of the categories (glottic closure, glottic closure classification, mucosal wave, symmetry, or classification) were significant with this analysis (**Table 5.55**).

Table 5.55 - High-speed imaging parameters and group comparisons: post vs. 1-month*

	Change from Post to 1-Month*				p-value for Test of Group Difference**
	ASP (n=10)		VFE (n=10)		
	Median (IQR)	p-value	Median (IQR)	p-value	
High-speed visual imaging					
Glottic closure	0.0 (0.0, 0.0)	1.00	0.0 (0.0, 0.0)	1.00	0.84
Glottic closure classification	0.0 (-2.0, 2.0)	1.00	0.0 (0.0, 0.0)	0.75	0.75
Mucosal wave	0.0 (0.0, 1.0)	0.25	0.0 (0.0, 0.0)	0.50	1.00
Symmetry	0.0 (-1.0, 0.0)	1.00	0.0 (-1.0, 0.0)	1.00	1.00
Classification	0.0 (0.0, 0.0)	--	0.0 (0.0, 0.0)	1.00	0.47

*Wilcoxon signed rank test exact test. IQR, interquartile range.
** Wilcoxon rank sum test.

Discussion

From the first two components of this dissertation we have established the need for improved classification of the elite vocal athlete voice, identified aging related vocal and performance changes that exceptional singers have reported experiencing and expanded clinical considerations for optimal treatment of the aging elite vocal athlete. As discussed in Chapter two, vocal quality and function is often negatively affected by changes to the vocal mechanism due to aging.[24,26,32,34-36,70] The literature suggests these changes are chronic and this was corroborated by the reported experiences of aging elite vocal athletes.[1] These changes can not only affect income potential, but also significantly affect voice related quality of life.[108,111,248] However, before we can study the voice of the aging elite vocal athlete and recommend treatment options, we must first know how the typical aging voice responds to voice therapy exercises, specifically, VFEs.

This study aimed to examine a known voice therapy treatment option, VFEs, as an effective treatment modality for the normal aging voice[109,119,172,174,182,185,187,194] – to see if we can reduce the effects of normal aging on people who are not yet treatment seeking and examine how the normal aging larynx responds to vocal rehabilitation. The secondary aim of this study was to compare vocal function in individuals who have been treated with traditional voice therapy via VFEs to controls as determined by visual imaging (high-speed and stroboscopic), acoustic, aerodynamic, acoustic-perceptual, and patient subjective measures to see if using a multidimensional assessment of voice across the five domains will help to overcome limitations of using a sole assessment meaure.[253,254] The results from this study are summarized in the following sections with discussion relevant to each of the domains of voice assessment.

Subjective Measures Summary **(Tables 5.5-5.12)**

This study used the VHI, phonatory effort and vocal severity as subjective ratings for all three of the assessment points. Scores were compared between the two groups (VFE and ASP). For the VHI, interesting results were seen as participants in both the VFE and ASP group scored worse on the VHI at the post-therapy assessment (60% for both VFE and ASP). This is in contrast to what is usually reported in voice outcome studies where the VHI score is often the outcome measure that reflects a change (for the positive) after intervention. This increase in scores across both groups was gone at the one-month mark for the VFE group (90% of participants scored lower than their baseline and one was the same) but 30% of the ASP group continued to report increased VHI scores at this point. This contrasts the findings in Sauder et al.[182] where improvement was noted in all subjective measures (VHI, voice severity and phonatory effort) following intervention. From this surprising find, we hypothesize that since this study population was not a treatment seeking population they did not initially think/or were aware that they had a voice problem. After performing voice exercises (control or ASP) twice a day for 6 week and reading all the subjective voice-related questions at the initial evaluation, it is possible that the participants began to realize that they did, indeed, have some problems with their voice. This effect was noticed the strongest immediately following intervention, and the one-month scores reflected a more "expected" distribution of VHI improvement following direct intervention where both groups had participants with lowered VHI scores. This finding suggests that while the VHI reflects the patient's perception of their voice issues, if they don't believe they have a problem it does not necessarily identify voice issues. Additionally, the mere act of "doing something" in the way of intervention appears to (in this pilot data) make the participants aware of vocal issues that they previously did not consider to be a problem. This raises some interesting questions for future work.

Comparisons of phonatory effort and vocal severity ratings for both groups were not statistically significant and did not reveal any unique patterns.

Auditory-Perceptual Measures Summary **(Tables 5.13-5.20)**

Auditory-perceptual analysis was assessed using the CAPE-V by two licensed and certified speech-language pathologists with over 40 combined years of experience in the specialization of voice disorders. Assessors were blinded to group assignments. There was no significant difference in CAPE-V scores between the VFE and ASP group across any of the parameters (overall severity, loudness, breathiness, roughness, strain, and pitch). Score in various domains were clinically abnormal for two participants in overall, roughness, breathiness, strain, and loudness for the VFE group. All measures were clinically normal for the ASP group. Comparisons of the initial and post-therapy assessment were statistically significant for loudness.

The findings demonstrate that the voice quality of both groups, VFE and ASP was similar, although 20% of the VFE group was clinically abnormal in several categories initially with improvement to normal values following intervention. This finding is consistent with the Sauder et al.[182] where no noticeable change was measure in auditory-perceptual measured following intervention.

Acoustic Measures Summary **(Tables 5.21-5.33)**

The measures of f_0, jitter, shimmer, NHR, MPT, pitch range, and the CSID values of /a/, EOS, VPS, AVS, and HGAS were collected for both groups at all assessment points. The measure of f_0 from a sustained /a/ was found to improve for 60% of VFE members and worsen for 20% of ASP participants at the post therapy assessment. Those gains were lost for all but one participant in the VFE group at the one-month mark and improve for 50% and worsen for 20% of the ASP participants at one month. The improvement (increase in f_0 for women and decrease in f_0 for men with presbylaryngeus) was expected following VFE intervention (e.g., pre f_0 195 Hz, post tx f_0 146 Hz, one month f_0 175 Hz) and was clnically significant. The increase of the woman in the ASP group at the one month mark was slight and not clinically relevant (e.g., pre f_0 153 Hz, post tx f_0 165 Hz, one month f_0 163 Hz). Jitter measures were approaching significance (p

= 0.11) with clinicially abnormal scores decreasing at the post therapy and one month assessment point for the VFE group and significantly increasing at the post therapy assessment with scores similar to baseline for the ASP group. Shimmer measures improved for all VFE members to clinically normal values at the post therapy assessment with a slight decline at the one-month asssessment. The ASP group did not have any noteable improvement at either post therapy assessment point. NHR measures were grossly normal for both groups at all assessment points. One participant in the VFE group measured a clinically abnormal value initially which resolved by the post-therapy assessment. The majority of the VFE group (80%) measured an increase in MPT at the post therapy assessment and maintained by 70% at the one month assessment. The ASP group found a 40% increase compared to baseline with only two out of ten improved at the one-month assessment. Increased MPT suggests improved glottic closure and better efficiency of the three subsystems: respiration, phonation, and resonance. This correlates to the findings of the stroboscopic and high-speed imaging domains of voice assessment.

The Analysis of Dysphonia for Speech and Voice (ADSV) was used to analyze connected speech and sustained phonation. Cepstral Speech Index of Dysphonia (CSID) values were analyzed for sustained /a/ and the following sentence types: easy onset (EO), all voiced (AV), voiceless plosives (VP), and hard glottal attacks (HGA). CSID measures were only statistically significant for AV ($p = 0.06$) however there were clinically significant findings in additional categories. For /a/, improvement was noted at the post therapy assessment and maintained at the one-month assessment. The ASP group had multiple members (40% and 60%, respectively) with clinically abnormal scores at baseline and post therapy points with a decrease to two participants still increased at the one-month assessment. Values for the EO and VP sentences were similar between groups with no notable improvement. The outcomes for the AV sentence were interesting as there was an increase in clinically abnormal values in the VFE group and a decrease in the ASP group at the post therapy and one-month assessment points.

The final acoustic measure of range found ascending range to be statistically significant ($p = 0.01$) with 70% of VFE participants increasing in range by one semitone (ST) to almost a full octave. At the one-month assessment six of those members maintained their increased range. This is particularly promising when considering the application of VFEs for the aging singing voice. The ASP group had a small increase (1-2 ST) in 50% of participants at the post-therapy assessment while 40% measured a decreased range of 3-6 ST. This worsened to 60% of the participants with a decreased range at the one-month evaluation suggesting while the ASP sentences are voice use and may have elicited some minor change, this was not enough to carry over to the singing voice range. Compared to the Sauder et al. study that saw no change in acoustic parameters, this study was able to identify statistically significant changes in multiple measures (jitter, shimmer, ascending range and AV sentences) with clinically significant changes in other measures, as discussed above.

***Aerodynamic Measures Summary* (Tables 5.34-5.41)**

Aerodynamic analysis included: vital capacity (VC), mean airflow rate during voicing (MAirflow), subglottic pressure (Psub), laryngeal airway resistance (LAR), and phonation threshold pressure (PTP). Of these five measures, MAirflow was the only found to be stastically significant at the post-therapy assessment ($p = 0.02$). MAirflow saw a decrease in the one-month assessment of 40% to 20% in the VFE group with clinically elevated values and the ASP group saw an increase from 30% to 40% with clinically elevated values. MAirflow is suggestive of glottal incompetency.[259] No significant changes were noted in VC for either VFE or ASP. MPeak values were fairly similar across group with both groups having multiple members with clincially abnormal values at the initial assessment with a small improvement across the whole cohort at the post-therapy and one month assessments. ARes had more members with clinically abnormal values at baseline, however both groups had similar presentations at both the post-therapy and one-month assessments. The final aerodynamic measure was PTP. Increased PTP is suggestive of supraglottic hyperfunction and increased phonatory effort.[259] We found a similar number of participants (40%) in both groups at baseline. At the post-therapy assessment the VFE group had 30% and the ASP group worsened to 60% and this trend continued at the one-month assessment with 10% with clinically abnormal value in the VFE group and 40% in the ASP group.

***Stroboscopic Measures Summary* (Tables 5.42-5.48)**

Visual imaging of the appearance and vibratory characteristics of the vocal folds was performed by a licensed speech-language pathologist specializing in voice disorders using a laryngeal videostroboscopy system. From that recording, the following parameters were assessed by two voice speciality SLPs to were blinded to group assignment and presented with randomized samples for analysis: glottic closure, glottic closure classification, mucosal wave, symmetry, and overall classification. The stroboscopic exams were judged independent of the high-speed imaging videos.

Statistically significant findings were seen at both the pre to post-therapy assessment points and the post-therapy to one-month assesment points for glottic closure, ($p = 0.03$, $p = 0.08$), symmetry ($p = 0.10$, $p = 0.07$) and overall classification ($p = 0.03$, $p = 0.09$). Regarding glottic closure, the VFE group had 80% at baseline with a small to large glottic gap. This improved to 50% at the post-therapy assessement while participants lost the majority of those gains at the one-month mark. 100%of the ASP group had a small to large gap at baseline and there was no notable difference any of the assessment points. Glottic closure classification had similar results with 80% of the VFE participants having either an anterior, posterior, or spindle shaped glottal gap. This reduced to 40% at the post-thearpy assessment and those gains were mostly lost (70% with gaps) at the one-month assessment. Again, the ASP group had no full resolution of glottic gap at any point. The ratings for MW were fairly similar between the two group at all of the assessment points. There was a significant improvement in symmetry with 50% of VFE participants rated as asymmetrical at the initial assessemnt and a reduction to just 10% at the post-therapy assessment. There was a slight increase (to 30%) of asymmetry at the one-month assessment. No clinically significant change was noted in the ASP group. The most interesting stroboscopic data was with the final category, overall classification. In both groups, 100% of participants were judged as presbylaryngeus at the initial assessment. This improved to 50% judged as normal at the post-therapy assessment and regressed to 90% presbylaryngeus at the one-month mark. There was no change in status in the ASP group across all points.

***High-Speed Imaging Measures Summary* (Tables 5.49-5.55)**

The same parameters were assessed on the high-speed images: glottic closure, glottic closure classification, mucosal wave, symmetry, and overall classification. Two parameters came out as statistically significant for high-speed imaging domain: glottic closure ($p = 0.03$) and overall classification ($p = 0.03$). Comperable to the strobscopic results, the VFE group had 80% with a glottic gap at baseline and with improvement to 40% at the post-therapy assessment and a slight decline to 50% at the one month assessment. There was no difference in the ASP group. Glottic closure classification was also similar with 80% of the VFE participants having a glottic gap ranging from anterior to spindle shaped that improved to 40% at post-therapy with a slight increase to 50%at the one-month assessment. Again, there was no change in the ASP group at any point. The parameter of MW was similar for both groups at all points. The ASP group had an increase in asymmetry at the post-therapy and one-month assessment while the VFE group remained fairly constant. The final parameter of overall classification revealed that 100% of participants were judged to be presbylaryngeus at initial assessment. The ASP group did not change at any point while the VFE group reduced to 50% with presbylaryngeus after intervention and 60% at the one-month assessment.

Conclusion

The results from the VHI is one of the most surprising outcomes of this work. The VHI is often a primary outcome measure for voice studies as it appears to do a reliable job identifying improvements in the subjective domain of voice assessment. Questions such as “People have difficulty hearing me when I call them in a noisy room” or “My voice is worse in the evening" should elicit reliable information about what effect their voice is having on their life even if they don't think they have a problem. To the contrary, our VHI findings suggest that people have to actually think they have a problem before they can reliably use these subjective rating scale as pre and post-test measures. This warrants further investigation.

Consistent to the Sauder et al. study we lacked significant findings for MPT. The results of Gorman et al.[172] found in increase in MPT and aerodynamic measures after VFE intervention. However, that study continued VFEs for 12 weeks instead of stopping at 6 weeks. Also, it is notable that Gorman et al. reported that the participants were still experiencing gains from the exercises when they stopped treatment. This suggests that our study results may be premature for the ideal time frame for patients using VFEs as a physiologic voice therapy intervention for presbylaryngeus. If patients are still experiencing gains at 12 weeks of VFEs, that raises the question of the ideal time length of exercises for patients with presbylaryngeus. The gains that were noted at the post-therapy assessment were often declining by the one-month assessment point. This is not surprising, particularly if we never got our participants to peak improvement due to a limited (6 week) intervention time. Future direction should not only include exploring the ideal length of VFE intervention needed as well as the benefits of continued vocal exercise and/or long-term taper/burst protocol to maintain improved vocal components.

The most promising results from this study are in the domain of visual-perceptual analysis. It was not surprising that 100% of the participants were judged to be presbylaryngeus on both the stroboscopic and high-speed imaging since they had been identified as having presbylaryngeus in a previous study. What is surprising is that in both the stroboscopic and high-speed imaging exams, 100% of the participants in the ASP group saw no improvement in their presbylaryngeus status at the post therapy or one-month assessment while the VFE group saw improvement in the majority of the group at the end of 6 weeks of VFEs although those gain were starting to regress by the one-month assessment. These finding support the use of VFEs as a treatment modality to help reverse laryngeal age-related changes. They also suggest that while all the domains of voice assessment did not see gains as expected perhaps we stopped the intervention too early. If we had continued VFEs for 6-12 additional weeks, it is hypothesized that we would have likely seen improvement in all 5 domains of voice assessment.

We know that aging voice is not a voice disorder, but it can create a voice quality that meets the definition of a voice disorder. This randomized control trial is unique as all of the participants, even though they have a diagnosis of presbylaryngeus, didn't recognize a voice disorder or vocal quality change in their voice so they didn't think they had a voice problem. This allowed for the rare opportunity to study Vocal Function Exercises as an intervention for presbylaryngeus without the traditional voice therapy influence of having a treatment seeking patient who is both ready for and expecting change in order to avoid what Sauder et al, called "the reactive effects of clinical interaction". To this end, this study has provided us with preliminary data regarding the efficacy of VFEs in the aging voice population. The preliminary results from this study are positive and build on the previous studies using VFEs as a treatment modality for presbylaryngeus. 109,119,172,174,182,185,187,194

Limitations

While this study design (RCT) bring strength to the results, one potential limitation of the study is that it was a single-site study conducted solely at the University of Kentucky Laryngeal and Speech Dynamics Lab. Data from study will be used as preliminary data to support a future multi-site study of treatment seeking individuals. Future research could also include repeating the study to identify the typical time for patients to reach their peak potential using the VFEs as well as the benefits of a maintenance plan for the VFEs.

Another limitation is the duration of study intervention (VFEs). In the clinical setting, the typically timeframe for voice therapy for patients with presbylaryngeus is 6-8 sessions over 3-4 months. This study was limited to 6 weeks of intervention. Since the vocal fold muscles respond similarly to exercises as limb skeletal muscles, we know that we can expect to see a change in the muscle at this point. The change is enough to be noticeable, but not enough for full resolution of symptoms. It is possible that if the participants had continued on with VFEs until their voice symptoms were resolved, results may have had increased significance and any loss of results at the one-month assessment point may have been less significant.

Findings of this study are in accordance with the previous studies using VFEs as a treatment modality for presbylaryngeus, but should be interpreted with caution until this study is replicated or performed with a larger sample size to confirm these results and allow for inferential interpretations and generalizability.

Summary

The next chapter presents component four of this dissertation, a study of the vocal and performance changes observed in select male elite vocal athletes from their early years performing through their prime and into the final phase of their career.

CHAPTER 6: GROWING OLD AS A ROCK STAR – HOW DO THEY DO IT?

Overview

Chapter 6 describes the fourth and final component of this dissertation, a descriptive study examining vocal and performance techniques of elite vocal athletes across their lifespan. In Chapter 5, we examined the efficacy of Vocal Function Exercises as a treatment modality for aging voice and results suggest that they are an effective treatment modality for improving presbylaryngeus. As we continue our research into the aging singing voice, we also build upon what we learned from component two – Against the Wind – Singers Growing Old. From this, we were able to identify the type of vocal and performance problems that elite vocal athletes are identifying as age-related changes and how they report to be accommodating to such changes. The next step in our comprehensive analysis of the aging elite vocal athlete involves a comprehensive look at the performing careers of selected singers, all whom have exceptional voices, to examine how their reported changes correlate to actual accommodations of age related vocal and performance changes over the span of their career.

Background

By now, we know that singing is no easy task. It requires a balanced interaction among the three subsystems of voice production: respiration, phonation, and resonance. It is obvious that elite vocal athletes have voices that are different than the general population; voices that are exceptional. They are without question, a vocally special group. It is known that elite vocal athletes of all ages are at increased risk for developing voice problems due to their profession compared to the general population because they have extra demands on their voice.[205] As the anatomy inherent in all three subsystems of voice production ages, voice quality often diminishes in spite of good vocal hygiene habits, directly impacting the performance career of aging elite vocal athletes. Although singers often seem larger than life and invincible, we must remember that they aren't superhuman and while it may seem their music is timeless, their voices are not.

Elite vocal athletes are a subset of the aging voice population and we have suggested that treatment and concerns for them are very different than for the non-singer and need to be researched further regarding the implication of aging voice changes. The loss of the singing voice due to aging may seem inconsequential; however, emerging data shows that those facing this reality may find it career halting with significant financial implications that are far-reaching beyond just the performer. [1] Against the Wind – Singer's Growing Old, suggested that the impact may be felt deeper for elite vocal athletes for whom aging voice changes can significantly threaten or even end their successful performing careers. Regardless of these changes, most singers are highly driven to continue performing for as long as humanly possible. [212,223,225,260] In fact, many singers view death on stage as a fitting final scene for their lengthy careers. [236,247,261] Those facing this reality may experience significant life changes due to an inability to perform. [230] Additionally, due to the changing music industry, aging elite vocal athletes in the contemporary commercial music (CCM) genre are often forced to return to active concert schedules to maintain their income. [212,234,262] Although these voice changes affect the artist primarily the economic impact of a cancelled show has a ripple effect throughout the entire production that financially impacts all those involved as well as the local economies of each tour site. Elite vocal athletes generally do not have the luxury of taking several weeks or months off a tour to participate in a vocal rehabilitation program. [223,237,260] They are forced to continue performing with a vocal mechanism that is potentially weakened due to aging voice changes even though this significantly increases the risk for diminished vocal stamina, decreased vocal range, less than optimal performance quality, and an overall increased risk for further vocal injury.

The price of longevity in the performing career of a rock star is very high - it often seems there is a trade-off between physical and vocal agility and age. As they enter the final scene of their performing careers, singers struggle with acknowledging and accommodating to changes in their voice and anxiety about being able to perform as they did during the peak of their careers. Like professional sporting athletes, elite vocal athletes are challenged by age to maintain the necessary physical skills to sustain their professional performing careers. This was painfully apparent when Paul Simon sang "Bridge Over Troubled Waters" at the 2016 Democratic National Convention. His performance immediately went viral on social media where it was ruthlessly critiqued by the general public. One user wrote, "He looks genuinely weary and the one needing to be led over the troubled waters of vocal decrepitude." Another said, "In utmost, honesty, Paul Simon should have laid himself down before he committed vocal butchery on this masterpiece." The initial comment on the video was equally as painful, "Paul Simon is FRIED!!!!!!!!!! This is the worst excuse for an old hippie trying to regain some semblance of his old self. Hey Paul, you sucked. My dead grandmother sounds better than you." A few fans tried to stand up for the aging performer, albeit with an ageist viewpoint, stating, "well he didn't sound like he did years ago but for a 74-year-old, can he be forgiven for being old? I'm sure he wishes he wasn't old but that's what time does to a singer's voice. …He isn't quite as good as he was in the 60's and 70's but he is still really good at 72 [*sic*]." [263] Interestingly, regardless of the final opinion of the audience, these aging rock stars continue to command an audience and capture the attention of the world with each performance.

From the previous dissertation components, we have learned that aging singers are aware of and often struggling with aging vocal problems. We have also learned that intervention on the normal aging voice has the ability to impact a positive change on the voice. This study aims to further analyze what these elite vocal athletes appear to be doing about their problems to successfully navigate a performance.

The current state of the literature suggests that there is significantly limited data regarding this topic. This raises the question: What can be done to strengthen and sustain the singing voice for these aging singers to subsequently lengthen their performing careers and optimize their vocal health? To answer the question, we must first begin to understand the unique experiences of aging CCM elite vocal athletes; what they are experiencing, how they are adjusting, and the success or failure of their continued adaptations. This study is the fourth in this series of research studies designed to explore the awareness, struggles, and vocal/performance compensations of aging singers dealing with age related vocal and performance problems.

Research Questions

The purpose of this study was to examine the selective performances of older male elite vocal athletes. This study builds on the data and knowledge that we have gained from the first three parts by exploring and comparing the performances of CCM male elite vocal athletes across their lifespans. It examines how/if the changes that come with age affect the performances and singing of older male CCM singers and how/if these aging singers are successfully crafting a stage show that is pleasing to the audience when they are struggling with the anatomic and physiologic changes that occur in the aging voice producing mechanism. The following research questions were formulated:

1) What kind of age-related voice and performance changes appear to affect CCM male elite vocal athletes?
2) How do they adjust their performance to accommodate these changes?
3) What is the effectiveness of these changes on their performance based on the fan response?

Methods and Procedures

This study utilized a qualitative naturalistic observation design to observe the singers in their natural performing environment. The goal of naturalistic observational research is to serve as an initial starting point for investigating certain behavioral phenomena by watching what the participants "do naturally".[264] The research goal of this study was to identify changes in voice and vocal performance strategies, examine if and how performers accommodate to vocal changes, and explore when the accommodations are effective and when they are not.

Participants

The selected artists ranged in years from 71 to 93 (final analyzed concert) years old and were exclusively male. Women were excluded from this study due to the hormonal differences between female and males larynges that have been noted to possibly affect the singing voice, particularly during menopause. We followed the performances of the following artists - Billy Joel, Elton John, Rod Stewart, Tony Bennett, Bob Dylan, and Steven Tyler – by assessing various live recordings of entire performances at six points across their lifespan. These artists were selected due to the longevity of their careers, the fact that they are all still actively performing, and that they have full length live performances readily accessible on YouTube. The University of Kentucky's Office of Research Integrity determined that IRB approval was not required for this study design as the data used for analysis was readily available for public use.

Search keywords for YouTube included: full concert, full length, full show, with the artist's name. Concerts released by the artists' management teams were excluded as there is a higher likelihood of editing for such recordings to remove less than ideal vocal/performance moments. Concerts that were recorded by concert attendees on their personal media such as VHS tapes or cell phones were selected, if possible, for the least likelihood of editing. Due to the relatively recent accessibility of affordable technology to film concerts, most concerts available start around 1976 which is the 3rd or 4th decade for most of the artists. At this point in their careers they had been performing for at least 10-

20 years and should have worked through any initial performance development issues. Once a group of unedited concerts was obtained for each singer, six concerts were picked to be spaced at least 5-10 years apart, if possible, across their career.

Materials

Observational data sheets (**Tables 6.1** and **6.2**) were developed and used to record the field notes collected in this study and ensure that the necessary details were captured.

Table 6.1 Data sheet for concerts

Singer____ Total Concert Time:_______

Concert Date: ___________________________________ Total Time Singing:_______

Age:________ Percentage Sang:_________

	Time singing	Instrumental filler time	Back up filler time	Opening singer filler reprise time	Distracting behaviors time	Duets time	Length of vocal breaks	Compensatory behaviors (separate table – measure length) (y/n)

Table 6.2 - Data sheet for compensatory behaviors

Song	Compensatory Behavior	Clinical Observation

Table 6.1- Data sheet for concerts was designed to collect multiple variables including total concert time, time singing, and all other time that was not directly spent singing or for the instrumental part of the song. These variables included instrumental filler time (songs with no vocals at all), time performing by back-up singers, opening singer time, any types of distracting behaviors, and duets with others along with the presence or absence of observed compensatory behaviors. **Table 6.2**– Data sheet for compensatory behaviors was designed to further document and describe any identified compensatory behaviors for analysis. These data sheets were filled out for all singers at each of their six concert points. A master coding sheet was also developed and used to categorize the information from the observational data sheets. Episodes of performance and vocal accommodations were identified and those with similar purposes were coded together into a more general category. An example of general category would be lowering the key of a song, dropping upper notes, and removing physical movement.

Comments related to vocal and/or performance changes that were left by the fans at the online concerts page were collected a master spreadsheet for each singer and concert for later analyzation.

Procedures

In order to determine the feasibility of the observational data sheets and the coding sheets along with the reliability of the coding procedure, the primary researcher and a research assistant met for training to complete the forms for a concert by an aging singer who was not used in the study. The primary researcher was the author of this dissertation and is a licensed and certified speech-language pathologist with a background as both a performer and vocal teacher. The research assistant had a background in vocal music and performance. Both researchers agreed to keep field notes of data collection during the concert analyzation to later assist the primary researcher in coding and analyzing the data. The trained research assistant was not involved in the data analysis process. The two researchers independently completed the data sheets for the concerts and the compensatory behaviors at the same time. Inter-relater reliability between the two coders was 93%.

Reflexivity was addressed by the primary research through acknowledging personal experiences and biases that could influence the analysis which was included in the Prologue. Validity was established through methodological triangulation using both qualitative and quantitative methods to study the research questions. Findings for the various outcome measures and concert analysis were compared to see if similar results were found. While the focus was on the aging voice changes in the male CCM singers observed across early to late concerts, additional methodological triangulation was achieved by incorporating insights from published YouTube comments of concert attendees and fans who either viewed the concerts online or attended in person and later chose to provide feedback. Videos that are available on the YouTube platform offer viewers the opportunity to comment on the video. These comments are rich in qualitative data and allow insight into the audiences' experiences and thoughts regarding the performance. These comments represented the audience's perceptions of the nature and implications of aging CCM performers vocal changes. An audit trail was also maintained to provide a transparent path of the data (including additional notes by the researcher and assistant during the observation stage) and all of the decisions made by the researcher in this study.

The process of collecting the data using a naturalistic observation design followed the typical procedural arc where the primary research and research assistant acted at complete observers. The process began with descriptive reporting. The focusing phase used focused observations targeting the research questions and observing factors of particular interest with greater intensity, while making sure that how those factors fit in the larger context is maintained. Repeated observations of multiple concerts allowed for the discernment of patterns. Finally, the selective phase focused on establishing and clarifying relationships between the various elements in the research. [265-267] Through the focused phase of data collection, the strategies the performers were using were documented for further analysis so that I could examine these for patterns and discuss what was working and what they could be doing more efficiently. For example, Elton John was observed to no longer use high falsetto on phrases in his song, Rocket Man. He was accommodating by dropping these phrases down an octave. The perceived audience reaction based on commentary was mixed with some commenters expressing understanding of the aging process, some upset that they did not hear the exact replication of the recorded process, and some commenters angry that they paid a high-dollar ticket price to see a show that they felt was not as good as when he was younger. While Elton John's accommodation to drop the pitch is an obvious choice for skilled musicians, it is a choice that will be noticeable to the audience and may or may not be well received. Another option would be to fill in this part with sound engineering -

overlaying the vocals from his youth to blend the two eras, old and young, and provide a less noticeable adjustment from the decreased upper falsetto range.

Statistical Analysis Plan for Quantitative Data

Methodology and data analyses involved critical content analysis of the performances with a particular focus on observations of performance changes that could be associated with aging vocal changes and how the performers were accommodating to the changes. Quantitative variables included measuring total singing time, length of vocal breaks, number of sung songs, and the use of instrumental and back-up singers to help carry the vocal load and other non-singing fillers. We then compared the early career to mid-career to late career for each individual singer and determined differences in the vocal load that may be associated with aging voice issues. We identified performance strategies used and discuss what was working and what they could be doing more efficiently (**Tables 6.1** and **6.2**).

Data reliability was obtained using an independent reviewer who assessed 20% (7 random concerts) of the concerts to establish reliability. The independent reviewer was trained using the data analysis sheets on a concert that was not included in the data set prior to analyzing the 7 random concerts. A paired t-test examined the outcome of singing percent by comparing the three career points. A repeated measures ANOVA was conducted on the three career points to evaluate whether the singing percent goes down as singers age. A mixed model repeated measures analysis looking at the six time points of measurement data was implemented, treating the first measurement as baseline and using it as a covariate in the model to further investigate the trend of singing percent over the time. The p-value for all data analysis was set at ($p < .010$) as this is pilot data.

Findings

The six internationally renowned singers have all demonstrated (through writings, interviews, and continued performance careers) an intense drive to maintain their performing career for as long as possible. We examined six different concerts across the careers (early career, mid-career, and late career) for each artist and recorded observations (**Table 6.1** and **6.2**) of vocal and performance changes across their careers. We also calculated percent sang (obtained by adding up total time sang divided by total instrumental) for each concert and compared these across the career. A final step was analyzing the comments left by viewers of the online concert that were related to voice and/or performance changes. Many fans are bluntly honest, perhaps even more so behind the veil of the internet, and provide insight into the fans reactions to their beloved rock stars getting old.

A total of 36 video concerts (six for each singer – Appendix XVII) for a total of 54 hours and 39 minutes were viewed and analyzed. The total concert time for each of the singers was between five hours and 54 minutes and 11 hours and 45 minutes. The distribution for each singer is displayed in **Table 6.3** below.

Table 6.3: Total concert time analyzed per singer

	Total Concert Time Analyzed
Tony Bennett	5:41:00
Billy Joel	11:45:00
Steven Tyler (w/Aerosmith)	8:48:00
Elton John	11:44:00
Rod Stewart	8:53:00
Bob Dylan	7:48:00
Total	**54 hours, 39 minutes**

The current age of the singers ranged from 71 to 93 years (mean 76.3 years, SD: 7.88) and years performing ranged from 48 to 69 years (mean 55.5 years, SD: 7.58). The total amount of shows performed across their career ranged from 1,484 to 3,894. Total show information was obtained from the website www.setlist.fm and may not be complete totals. All artists have sold between 50 million and 300 million total records and have produced between 13 to 57 studio albums. Number of tours is not representative of total years as some tours (e.g., Bob Dylan's "Never Ending Tour") last for multiple years. Singer demographic information is available to for review in **Table 6.4**.

Table 6.4: Singer demographics

	Current Age	Total Records Sold	Studio Albums	Shows	Years Performing	Tours
Tony Bennett	93	50 million	57	1998	69	4
Billy Joel	70	>150 million	13	1484	48	22
Steven Tyler (w/Aerosmith)	71	>150 million	15	2381	49	32
Elton John	72	300 million	30	3894	51	59
Rod Stewart	74	120 million	31	2236	54	30
Bob Dylan	78	>100 million	38	3735	62	13

Singer 1 – Tony Bennett

Tony Bennett is currently 93 years old and on his sixty-ninth year of performing with a total of 1,998 shows. He has recorded fifty-seven studio albums and sold over 50 million records (**Table 6.4**). Six of his concerts (1966, 1974, 1981, 1991, 2002, and 2018) were analyzed for a total of 5 hours and 41 minutes. The selected concerts ranged from 15-21 songs with a total concert time between 44 minutes and one hour 13 minutes. At the early career point (first two concert points averaged together) his percent sang was 59%. Mid-career (third and fourth concert point averaged together) was 71.5% sang and late career (fifth and sixth concert points averaged together) dropped to 48% (**Table 6.5**).

Table 6.5: Singer 1 - Tony Bennett results

	1st	2nd	3rd	4th	5th	6th
Total Concert Length	52:10	54:16	44:00	44:28	1:13:00	1:13:00
Number of Songs	17	16	15	16	20	21
Total Song Time	50:20	47:43	38:31	38:31	56:05	1:03
Total Time Singing	26:41	31:01	27:26	28:24	30:04	26:08
Percent Sang	53%	65%	71%	72%	54%	42%
	Early Career	59%	Mid Career	71.5%	Late Career	48%

This reflected an increase in total singing time for the selected concerts during the second through fourth concerts with a decline beginning at the fifth concert and continuing through his last concert data point.

Tony's vocal genre is that of a crooner; he made a career out of singing standards that require a relatively limited vocal range and makes great use of the microphone as a tool across the show. He uses this as a stylistic advantage to supplement vocal intimacy with volume. He possibly learned that technique from his friend, Frank Sinatra, who once said, *"I discovered very early that my instrument wasn't my voice", Sinatra said. "It was the microphone"* [218] Tony was open about discussing vocal techniques and tips with other musicians. He said,

> *"Some singers' voices start to wobble when they get older. I once asked Sinatra what he'd do to beat wobbling, and he said he wasn't sure, but that if it ever started to happen to his voice, he'd just quit. To avoid that, I work every day doing by scales, and I really concentrate on holding my notes without vibrato. A dear friend and accomplished musician, Abe Katz, who was the first trumpet for the New York Philharmonic, told me that he holds notes with no vibrato, as that's the best way to keep focused*

> *so the notes remain strong and clear. And that works for singing, too. If my voice does start to falter at some point, I guess I'll just become a painter."*(p. 238-239)[226]

He also spoke openly about his desire to keep singing as long as possible.

> *"The late jazz vocalist Joe Williams told me, "It's not that you want to sing; it that you have to sing." And that is true – I have to do it. I can't think of a nobler occupation than to try and to make people forget their problems for an hour and a half. You lift up their spirits and give them a feeling of hope…"I have no desire whatsoever to retire; if I'm lucky, I just want to get better as I get older."…"There are a lot of things I want to do. I'm blessed with the fact that I have my health, and my wish is for this to continue, so I can keep plugging away for a long time. Long ago, I realized that nobody beats death. You're as good as your last breath. Duke Ellington said it best: "Number one: Don't quit. Number two. Listen to number one." (p239-240)*[226]

Tony has taken this advice to heart as he continues to perform regularly with no sign of stopping. He does appear to be experiencing both vocal and performance changes in his late career as reflected through observations of the recorded concerts and fan comments regarding the performances across the six career points. We will now discuss each of his six concerts and the observations and audience reactions as he ages.

Concert 1

The first concert point for Tony was in 1966. At this point he had been performing for sixteen years. This concert was 52 minutes in length and included 17 songs. Total percent sang was 53% (**Table 6.6**).

Table 6.6: Singer 1 – Tony Bennett – concert 1

Tony Bennett 1966 Concert			
Set List	Song Length	Total Time Singing ONLY	
1. Who Can I Turn To	2:21	1:16	
2. Because of You	2:39	1:39	
3. Taking a Chance on Love	2:00	1:40	
4. The Shadow of your Smile	4:07	2:30	
5. Sing you Sinners	10:05	1:55	
6. If I Ruled the World	3:29	2:00	
7. Fascinating Rhythm	0:42	0:26	
8. I Left my Heart in SF	2:39	1:55	
9. Just in Time	0:59	0:49	
10. A Taste of honey	2:46	1:54	
11. When Joanna Loved Me	3:11	1:53	
12. Keep Smiling at Trouble	2:38	1:37	
13. Lost in the Stars	4:08	2:43	
14. Firefly	0:59	0:39	
15. How Do You Keep the Music Playing	2:12	1:05	
16. The Best is Yet to Come	2:45	1:24	
17. The Trolley Song	2:40	1:16	
Totals	50:20:00	26:41:00	**Percent Sang:** 53.01 %

Clinical observations from the recorded concert did not include any age-related vocal of performance concerts. Tony traditionally performs with a full orchestra and has minimal choreography across his shows. He was noted to have a strong, consistent vocal quality with no noted areas of concern. Percent sang for this concert was 53% (**Table**

6.6). This concert was watched by 9,146 viewers online and included 23 comments, all of which were positive and three were specifically related to voice quality (**Table 6.7**).

Table 6.7: Singer 1 – Tony Bennett – concert comments

	Total Views	Total Comments	Voice -Positive	Voice - Negative
1966	9,146	23	3	0
1974	5,783	11	0	0
1981	3,905	6	1	0
1991	254,056	104	3	0
2002	256,196	85	2	0
2018	1,645	7	2	2

"Tony nearing his vocal peak...his voice much much more beautiful as he matured....listen to his live 62 album...and while his voice is powerful…it lacks the warmth it will show in about 4-5 years from this show." (user JZ) Another user wrote, *"Sublime voice of Tony Bennett."* (user E10) and user DD commented, "*Wow! They don't make specials like that one any more. Tony, you have a terrific voice and boundless energy. We're all grateful you've made your mark in the music world and brought much beauty to us all."*

Concert 2

The second concert point is in 1974. The total concert length was 54 minutes and included 16 songs. The total percent sang for this concert was increased to 65% (**Table 6.8**).

Table 6.8: Singer 1 – Tony Bennett – concert 2

Tony Bennett 1974 Concert			
Set List	Song Length	Total Time Singing ONLY	
1. The Good Things in Life	4:00	2:19	
2. My Favorite Things	2:16	1:21	
3. My Love	3:20	1:38	
4. I've Got Five Dollars	2:48	2:05	
5. They Can't Take That Away From Me	2:23	1:47	
6. The Summer Knows	3:37	2:28	
7. Girl Talk	2:42	2:03	
8. All That Love Went to Waste	2:39	1:57	
9 Let's Fall in Love	2:17	1:34	
10. I Left my Heart in SF	3:18	2:43	
11. Just in Time	2:02	1:27	
12 Because of You	3:17	2:11	
13. Don't Get Around Much Anymore	2:00	1:30	
14. Sophisticated Lady	2:47	2:26	
15. Don't Mean a Thing	4:20	0:37	
16. Maybe This Time	3:57	2:55	
Totals	47:43:00	31:01:00	**Percent Sang:** 65 %

Clinical observations noted an even balanced vibrato at the start of the concert with a transition to a machine gun quality vibrato on the song *Don't Get Around Much Anymore* (song 13 out of 16). There was no vocal strain noted and he even added in a little more movement than usual, skipping a bit during the song *Let's Fall in Love*. This concert was watched by 5,783 viewers and included 11 comments, none of them focused on voice or performance changes that could be attributed to aging (**Table 6.7**).

Concert 3

The third concert was in 1981 and was 44 minutes in length. It included 15 song and continued the trend of increased percent sang to 71% (**Table 6.9**).

Table 6.9: Singer 1 – Tony Bennett – concert 3

Tony Bennett **1981 Concert**			
Set List	Song Length	Total Time Singing ONLY	
1. I Left my Heart in SF	1:49	1:41	
2. I Love You	1:35	0:46	
3. Fly Me to the Moon	3:18	2:15	
4. More Than You Know	3:25	2:33	
5. My Favorite Things	2:16	1:20	
6. Body and Soul	4:00	2:57	
7. As Time Goes By	3:00	2:30	
8. Yesterdays	1:57	1:27	
Intermission			
9. There'll be Some Changes Made	2:28	1:52	
10. Maybe This Time	3:40	2:39	
11. This Can't Be Love	1:42	1:04	
12. My Funny Valentine	3:35	2:05	
13. Just in Time	1:42	1:11	
14. Who Can I Turn To	2:20	1:13	
15. Because of You	2:04	1:53	
Totals	38:51:00	27:26:00	**Percent Sang:** 70.61 %

This concert is considered mid-career for Tony Bennett. Again, it is noted that he moves minimal during his concerts. Total time talking in between songs is less than 10 seconds and he often transitions to the next song with no introduction at all. This concert included a full orchestra backing him. The concert was watched by 3,905 viewers and included 6 total comments (**Table 6.7**). One user commented on his vocal quality, *"The ultimate crooner and a beautiful man in every respect."* (user VH)

Concert 4

The fourth concert was in 1991 and was also 44 minutes in length. The setlist included 16 songs and Tony hit a career high of 72% sang (**Table 6.10**).

Table 6.10: Singer 1 – Tony Bennett – concert 4

Tony Bennett 1991 Concert			
Set List	Song Length	Total Time Singing ONLY	
1. S' Wonderful	1:18	1:03	
2. Taking A Chance on Love	2:30	1:35	
3. Speak Out	3:09	2:15	
4. The Girl I Love	3:17	2:06	
5. When Do the Bells Ring for Me	3:10	2:15	
6. Just in Time	1:40	1:15	
7. Watch What Happens	2:02	1:42	
8. When Joanna Loved me	2:41	2:10	
9. I Left My Heart in SF	1:54	1:40	
10. Solitude	2:32	1:38	
11. It Don't Mean a Thing	1:11	0:16	
12. One For My Baby	2:19	1:36	
13. On The Sunny Side of the Street	3:08	2:52	
14. How Do You Keep the Music Playing	4:37	2:42	
15. Because of You	1:34	1:26	
16. Fly me to the Moon	2:29	1:53	
Totals	39:31:00	28:24:00	**Percent Sang:** 71.87 %

He started the concert with a three-piece band and added the full orchestra on the fifth song. It was noted that after he hit the powered falsetto in the song *When Do the Bells Ring for Me* (song five of 16) that he experienced vocal instability at various points throughout the rest of the concert. During this concert, he had the audience sing along during *On the Sunny Side of the Street.* This technique can be used to help cover vocal issues and/or give the singer a quick vocal break while making the audience feel included. He also forgot some of the lyrics for *One for My Baby.* This concert was watched by 254,056 viewers and included 104 comments with three notable ones (**Table 6.7**).

User SS remarked, *"I cannot help but feel, after following Tony Bennet most of my long life, that he was in the best voice of his career for this concert!"* Another user commented,

> *"Here at age 65 when most singers are losing their range and their vibrato starts to waver a bit too much, Tony is still in his prime. … THIS, is music. THIS is what a great singer sounds like. No effects, dancing girls, or other nonsense. Just a man with a mans* [sic] *voice, singing he* [sic] *heart out."* (user RJ)

The final comment was from JZ who also commented on concert 1.

> *"Bennett singing well here…. He forgets the words on one for my baby and I don't like what he does with solitude…ugg…but he is terrific as always on how do you keep the music playing…one of the few songs written in the last 50 years that belongs with the greats."*

Concert 5

The fifth concert was in 2002 and Tony performed 20 songs for a total of one hour thirteen minutes. His total singing percent decreased to 54% sang (**Table 6.11**).

Table 6.11: Singer 1 – Tony Bennett – concert 5

Tony Bennett **2012 Concert**			
Set List	Song Length	Total Time Singing ONLY	
1. Just in Time	1:37	1:16	
2. The Best is Yet to Come	2:24	1:30	
3. Over the Rainbow	2:36	2:16	
4. I Got Rhythm	1:50	2:00	
5. Stepping Out With My Baby	2:42	1:10	
6. For Once in My Life	3:48	2:11	
7. Smile	2:55	1:41	
8. When Joanna Loved Me	2:24	1:35	
9. The Good Life	2:40	1:39	
10. La Vie en Rose	3:16	1:11 - Duet	
11. Exactly Like You	3:24	0:56 - Duet	
12. What a Wonderful World	3:37	0:53 - Duet	
13. Who Cares	2:02	1:26	
14. Because of You	3:02	2:00	
15. I Wanna Be Around	2:14	1:34	
16. It Don't Mean a Thing	4:01	0:21	
17. I Left My Heart in SF	2:23	1:19	
18. New York State of Mind	2:58	1:27	
19. Fly Me to the Mood	2:32	1:30	
20. How Do You Keep the Music Playing	3:40	2:09	
Totals	56:05:00	30:04:00	**Percent Sang:** 53.65 %

This concert was also with a full orchestra with additional soloists and it was noted that while he talked more than his younger years it was still minimal. He included a spin during *Stepping Out with My Baby*, perhaps an attempt to add some extra pizzazz to make up for the obvious vocal decline. Clinical observations noted that his upper notes were not as clear as previously and beginning to show consistent vocal strain. He used videos during his concert and smiled more throughout the concert. He to talk-sang some of the lyrics that were more vocally difficult. Multiple songs had a longer instrumental break than previously and there were several songs with notes that were audibly hard for

Tony to hit (e.g; *What a Wonderful World*, *Fly Me to the Moon*, *It Don't Mean a Thing)*. Despite these issues, Tony was obviously having a great time as he noted that the crowd's energy was addicting to him, *"Anyone with a babysitter, get on home. I'd sing until 6am with a crowd like you."*

The concert was watched by 256,196 viewers who left 85 comments (**Table 6.7**). Two of these were pertinent to our study and both were positive. User ML commented,

> *"The very great, everlasting Anthony Dominick Benedetto, (90 today and will be 91 in on August 3) It's hard to believe that he was 76 at this concert, and still singing great as ever! Superb soloists, well, all of the orchestra also.) Thanks for posting this great concert in San Francisco. We love it! I believe he COULD have gone on until 6 in the morning, as he said! He truly is a "world citizen."*

The same user commented at a later date, *"What a great concert! I can't believe how he can spin around like that at age 76, 180 degrees, twice, and hold that long note like he does! Tony, you're just plain remarkable, and we love you!"*

Concert 6

The final concert point was in 2018 and included 21 songs over one hour thirteen minutes. Tony's total percent sang dropped to a career low of 42% (**Table 6.12**).

Table 6.12: Singer 1 – Tony Bennett – concert 6

Tony Bennett	**2018 Concert**		
Set List	Song Length	Total Time Singing ONLY	
1. Watch What Happens	2:11	1:32	
2 Who Got the Last Laugh Now	1:30	1:27	
3. This is All I Ask	2:54	2:00	
4. I Got Rhythm	1:50	0:32	
5. Solitude	3:31	1:31	
6. I'm Old Fashioned	5:32	0:40	
7. It Just Amazes Me	2:49	0:59	
8. Stepping Out With My Baby	2:00	0:59	
9. But Beautiful	4:37	1:28	
10. Love is Here to Stay	2:17	0:59	
11. The Way you Look Tonight	3:42	0:52	
12. Because of You	4:05	1:15	
13. Cold Cold Heart	2:46	1:10	
14. Who Can I Turn To	1:35	0:36	
15. Just in Time	0:57	0:37	
16. The Boulevard of Broken Dreams	2:14	1:06	
The Good Life	2:18	0:56	
17. How Do You Keep the Music Playing	3:40	1:37	
18. The Colors of My Life	3:21	1:28	
19. One for My Baby and One for the Road	1:30	0:51	
20. For Once in My Life	2:44	1:36	
21. I Left My Heart in SF	2:03	1:02	
22. Fly Me to the Moon	3:21	0:55	
Totals	1:03:27	26:08:00	**Percent Sang:** 41.9 %

He was 92 at the time of this concert and was showing undeniable age related vocal and performance changes. He is consistently using a "talk-singing" pattern with notable decreased vocal phrasing and vocal stamina. He had a difficult time with matching the pitch of the melody (e.g., changing the melody on *It Don't Mean a Thing* and *One For My Baby)* and seems to also struggle with the rhythms of the songs. His timing was off on multiple sings (e.g., enters a beat late on *Stepping Out with My Baby*) and forgets the lyrics during *The Way You Look Tonight.* His physical movements during the concert were guarded and slowed.

This concert was viewed by 1,645 fans who left seven comments, four of which address his voice (**Table 6.7**). The users compare Tony Bennett to Paul McCartney in their reflections. User DD remarked, *"Ouch. Yes, he can still hit a note here and there, but that wasn't anywhere even close to his performances of only 5-10 years ago. He's the best -- he's had a long, well-deserved glorious run, but no one can go on forever..."* User MF commented, *"I still find Tony at his age worthy of performing and still amazes me, at his age of 92 what he can do. Though I am very happy that my hero Paul McCartney currently still performs live, I find Paul more vocally embarrassing at 76 then Tony at 92."* User MS disagreed with an insightful remark,

> *"@MM Paul has to deal with the fact that he has to sing songs he wrote 55 years ago that had a LOT of high notes where if he lowers the key or whispers the vocals it doesn't sound like the same song. Tony was blessed with one of the strongest voices ever, but he can also talk through parts of the song and hit a few notes here and there and it still works, while Paul can't alter his songs that way and have it work."*

The original commenter, MM, replied

> *"Agree. I am happy Paul has not lowered the key to any of his catalog, to my knowledge, when he performs them live. As you said, it just would not be the same or as grand. Other heroes of mine do lower their keys of*

songs and it is a bit disappointing when I notice it. For certain, Paul does have a much more difficult job singing his songs than Tony...but I was commenting more referring even to his lower register songs and falsetto moments. It's just not the same, even when he is not singing high notes or his amazing rock belt out screams. Aging just sucks. I love Tony....and I love Paul and always will...

Singer 2 – Billy Joel

Billy Joel is currently 70 years old and has been performing for forty-eight years with a total of 1,484 shows. He has recorded thirteen studio albums (last new album was released in 1992) and has sold over 150 million records (**Table 6.4**). Six of his concerts (1979, 1990, 1998, 2006, 2014, and 2019) were analyzed for a total of 11 hours, 45 minutes. The selected concerts ranged from 16 to 25 songs with a total concert time ranging from one hour thirty minutes to two hours and nineteen hours. At his early career, percent sang was 50%, mid-career percent sang was 53.5% and late career percent sang was 50%, remaining fairly constant across his career to date (**Table 6.13**).

Table 6.13: Singer 2 - Billy Joel results

	1st	2nd	3rd	4th	5th	6th
Total Concert Length	1:30	2:19:00	2:15:00	1:36:00	2:02:00	2:03:00
Number of Songs	16	23	25	18	21	25
Total Song Time	1:13:02	1:58:01	1:38:22	1:26:41	1:40:43	1:49:22
Total Time Singing	39:36	54:03	54:34	44:45	49:15	55:41
Percent Sang	54%	46%	55%	52%	49%	51%
	Early Career	50%	Mid Career	53.5%	Late Career	50%

Billy's genre is soft rock/rock and roll and he is a singer/songwriter that has made a career out of his piano agility coupled with a power falsetto. Interestingly enough, he does not think that he has a good voice,

> "*For starters, I've never thought that I had a good voice. I can be objective about it. I like it better now that it's thickened out more at the bottom end than when I was younger, but I don't compare it to those naturally compelling voice I came up listening to. I can sing in key; I can sing in pitch. I can growl it up or rock it up of soul it up, but my natural voice, to me, is sort of like a kid singing in church."*[219]

He has also been open about his vocal changes as he ages and techniques he uses to cover them.

> *"Both men seem rather proud of the set's almost Houdini-like big dare, in which Joel warns the crowd that he may not be able to hit the high notes in "An Innocent Man." That he does it sitting down just enhances the stunt, Cohen says: "Is he gonna make it It's not just a falsetto, it's a powered falsetto." Says Joel, "I thought I said goodbye to that note when I did that album in my thirties."…Cohen quickly notes, "That's a good line to use." Later, Joel repeats the story onstage: "I wrote the song when I was thirty-four; I'm sixty-six – anyway, it didn't work out, but I got a song out of it."*

He has also been open about his poor vocal hygiene, including a history of smoking and drug and alcohol abuse and addiction. He has given interviews on record admitting to using heroin, cocaine, marijuana, and acid and performing while impaired from these substances. Joel today, states that he is in recovery having struggled with drug and alcohol abuse with rehab stints across his career.

Concert 1

The first concert point for Billy Joel was in 1979, at which point he had been performing for eight years. This concert consisted of 16 songs over one hour and thirty minutes. His total percent sang was 54% (**Table 6.14**).

Table 6.14: Singer 2 – Billy Joel – concert 1

Billy Joel **1979 Concert**			
Set List	Song Length	Total Time Singing ONLY	
1. Only the Good Die Young	3:32	2:37	
2. Moving Out	3:31	2:30	
3. Honesty	3:50	2:56	
4. My Life	4:55	2:37	
5. Piano Man	5:36	3:03	
6. All for Leyna	3:59	2:46	
7. Prelude/Angry Young Man	4:56	1:43	
8. New York State of Mind	8:54	3:27	
9. The Stranger	1:19	0:49	
10. Sometimes A Fantasy	3:34	2:03	
10. Root Beer Rag	2:41	0:00	
11. She's Always a Woman	3:18	2:34	
12. Stiletto	4:58	1:54	
13. Zanzibar	4:42	2:11	
14. You May Be Right	4:06	2:21	
15. Just the Way You Are	4:39	3:03	
16. Big Shot	4:32	3:02	
Total	1:13:02	39:36:00	**Percent Sang**: 54.22%

Clinical observations include examples of poor vocal hygiene (smoking a cigarette during the concert), vocal ornamentation during multiple songs that generally included power falsetto type vocalizations. His performance style at this time included dancing, acting and an overall focus on an entertaining stage show for his audience. He was noted to have a strong voice that was able to vocally perform everything he asked of it with no noted areas of weakness or concern although he did forget a lyric during the concert.

This concert was viewed by 25,811 fans who left a total of 40 comments, four of which were positively related to this study and two negative comments (**Table 6.15**).

Table 6.15: Singer 2 – Billy Joel - concert comments

	Total Views	Total Comments	Voice -Positive	Voice - Negative
1979	25,811	40	4	2
1990	11,036	15	2	0
1998	6,641	13	1	0
2006	617,305	218	6	3
2014	89,652	59	0	4
2019	22,338	53	3	0

User JH commented on the overall show, *"Now why wouldn't they digitalize this and officially release it as a lost live album? Fantastic!"* Another user, JN states, *"Billy Joel at his best! Awesome concert!!!"* One fan remarked on his performance, *"Saw him perform in Albuquerque on this tour. His energy was so amazing as he hopped and leapt around the stage, sometimes playing on four different pianos (lower let stage, upper left up a ramp & same set up on the right) during a single number"* (User EH). Finally, user S6 remarked, *"his best days,* *imho"*. Two viewers picked up on the dropped lyric. "*Forgot a lyric lol"* (user UM), and *"I thought his mic cut out. Hard to believe he'd forget that lyric."* (user LA).

Concert 2

The second concert was in 1990 and consisted of 23 songs over two hours and nineteen minutes. The total percent sang dropped for this concert to 46% (**Table 6.16**).

Table 6.16: Singer 2 – Billy Joel – concert 2

Billy Joel 1990 Concert			
Set List	Song Length	Total Time Singing ONLY	
1. Storm Front	5:36	2:55	
2. Allentown	3:39	2:12	
3. Miami 2017	4:04	1:55	
4. Prelude/Angry Young Man	5:08	1:31	
5. Scenes From an Italian Restaurant	7:14	3:00	
6. The Downeaster Alexa	3:29	2:04	
7. Goodnight Saigon	6:44	3:06	
8. I Go to Extremes	4:34	2:21	
9. Pressure	5:13	2:03	
10. Lennigrad	4:12	2:02	
11. An Innocent Man	6:05	3:27	
12. Big Man on Mulbery Street	8:54	2:06	
13. Shameless	4:18	1:59	
14. We Didn't Start the Fire	4:44	3:14	
15. Shout	5:32	1:43	
16. Uptown Girl	3:07	2:17	
17. It's Still Rock and Roll to Me	4:14	1:52	
18. You May Be Right	5:32	2:17	
19. Only the Good Die Young	3:43	2:04	
20. A Matter of Trust	5:00	2:22	
21. Big Shot	5:01	2:26	
22. Keeping the Faith	6:42	2:36	
23. Piano Man	5:16	2:31	
Totals	1:58:01	54:03:00	**Percent Sang:** 45.8%

During this concert, Joel was observed to add additional higher notes than on the studio album to *I Go to Extremes* and *Under Pressure,* adding scat singing to the start of *Innocent Man,* as well as adding extra instrumental to songs. He included the audience by having them echo phrases and had his drummer sing a verse. He was enthusiastically involved during the whole concert, even pretending to be attacked by a stuffed animal during the show. Clinical observations noted no vocal or performance issues that could be possibly due to aging.

This concert had 11,036 viewers who left 15 comments (**Table 6.15**). User LO stated about his performance, *"Wow, Billy in those days was a force of nature, too much cool."* Another viewer agreed with him, *"Thank you for posting, STORM FRONT is a classic album and a great concert, Billy was at the top of his game here!"* There were no negative comments for this concert.

Concert 3

The third concert in 1998 was at Christmas and included 25 songs over two hours and fifteen minutes. His total percent sang for this mid-career concert was 55% (**Table 6.17**).

Table 6.17: Singer 2 – Billy Joel – concert 3

Billy Joel	**1998 Concert**		
Set List	Song Length	Total Time Singing ONLY	
1. You May be Right	5:36	2:55	
2. Movin' Out	3:39	2:12	
3. Allentown	4:04	1:55	
4. She's Got a Way	5:08	1:31	
5. Don't Ask me Why	7:14	3:00	
6. Pressure	3:29	2:04	
7. Under the Boardwalk	6:44	3:06	
8. An Innocent Man	4:34	2:21	
9. My Life	5:13	2:03	
10. Gloria	4:12	2:02	
11. I Go to Extremes	6:05	3:27	
12. Prelude/Angry Young Man	8:54	2:06	
13. Goodnight Saigon	4:18	1:59	
14. Lullaby	4:44	3:14	
15. The River of Dreams	5:32	1:43	
16. We Didn't Start the Fire	3:07	2:17	
17. It's Still Rock and Roll to Me	4:14	1:52	
18. White Christmas	5:32	2:17	
19. Scenes from an Italian Restaurant	3:43	2:04	
20. Miami 2017	5:00	2:22	
21. Have yourself a Merry Little Christmas	5:01	2:26	
22. New York State of Mind	6:42	2:36	
23. Only the Good Die Young	5:16	2:31	
24. Souvenir			
25. Piano Man			
Totals	1:58:01	54:03:00	**Percent Sang:** 45.8%

Additional to his typical setlist, this concert included Christmas music through the show. Clinical observations were that he used a female back-up singer to cover the higher notes in *Innocent Man* although he added higher vocal parts than on the studio albums for *River of Dreams* and *We Didn't Start the Fire.* Joel exited the stage for four minutes prior to his encore exit of one minute. He avoided singing choruses of *Piano* Man by having the audience sing without him. No obvious age-related vocal or performance changes were noted during this concert.

This concert was viewed by 6,641 fans who left a total of 13 comments (**Table 6.15**). User MT stated, *"Here was Billy Joel at the prime of his life. Amazing Setlist!"* There were no negative comments.

Concert 4

The fourth concert was in 2006 where Billy Joel performed 18 songs for one hour and thirty-six minutes. The percent sang for this concert dropped slightly to 52% (**Table 6.18**).

Table 6.18: Singer 2 – Billy Joel – concert 4

Billy Joel	**2006 Concert**		
Set List	Song Length	Total Time Singing ONLY	
1. Prelude/Angry Young Man	5:21	1:31	
2. My Life	4:52	2:22	
3. Honesty	3:55	2:39	
4. New York State of Mind	6:46	2:54	
5. Allentown	3:39	2:17	
6. The Stranger	4:24	2:12	
7. Just the Way You Are	4:46	2:42	
8. Movin' Out	3:35	1:54	
9. An Innocent Man	5:55	3:59	
10. She's Always a Woman	3:28	2:30	
11. I Go To Extremes	4:40	2:04	
12. The River of Dreams	5:17	2:25	
13. We Didn't Start the Fire	4:34	2:40	
14. Big Shot	4:23	2:34	
15. IT's Still Rock and Roll to me	3:35	1:40	
16. You May be right	4:37	2:34	
17. Scenes for an Italian Restaurant	7:35	3:30	
18. Piano Man	5:19	2:18	
Totals	1:26:41	44:45:00	**Percent Sang:** 51.62%

Joel appeared to be in great performance shape for this concert with consistent energy. Notable for this show, the sound for his vocals, harmonica, and piano were all depressed during this show. The band was often almost overwhelming the sound – it is unclear if this was an attempt to draw attention away from his voice/performance or merely a technical error, however it lasted for the entire concert.

This concert was viewed online by 617,305 fans who left 218 comments, many of which were positive (**Table 6.15**). User EL remarked, *"Wow, his voice is still as strong as 30 something years ago."* PP replied, *"@EL I'd even go as far as to say "like fine wine: gets better with age"!".* User JT remarked that *"Billy Rocks still sounds the same after all these years"* and FC said, *"How can a guy still sing this good live after 40 plus* *years? Amazing".* There were also fans who acknowledge appearance changes, *"His hair might be gone; but his voice carries on"* (user S6) and the sound issues, *"I'm sorry to have to write this, but the sound quality is terrible…Too bad for a great performance"* (user RM), *"The band is too loud, imo, you can barely hear Billy Joel's amazing piano play & harmonica playing"* (user LT).

Concert 5

The fifth concert was in 2014 and included 21 songs over one hour and forty-one minutes. The total percent sang for this late-career concert dropped to 49% (**Table 6.19**).

Table 6.19: Singer 2 – Billy Joel – concert

Billy Joel	**2014 Concert**		
Set List	Song Length	Total Time Singing ONLY	
1. Miami 2017	4:45	2:14	
2. Pressure	4:45	2:11	
3. Vienna	3:28	2:06	
4. Fool in the Rain/Your Song	0:50	0:20	
5. Zanzibar	5:30	2:00	
6. New York State of Mind	6:36	2:30	
7. The Ballad of Billy the Kid	5:22	1:49	
8. Movin' Out	3:41	2:02	
9. And So it Goes	3:17	2:00	
10. Allentown	3:37	2:21	
11. Take it Easy	1:49	1:12	
12. She's Always a Woman	3:21	2:21	
13. My Life	5:04	2:34	
14. Don't Ask Me Why	3:30	1:55	
15. Highway to Hell	3:38	0:00	
16. Scenes From an Italian Restaurant	7:36	3:26	
17. The River of Dreams/A Hard Day's Night	6:34	3:27	
18. We Didn't Start the Fire	4:51	2:41	
19. It's Still Rock and Roll to Me	3:14	1:40	
20. Big Shot	4:27	2:42	
21. Piano Man	5:55	2:25	
22. You May Be Right	4:30	2:27	
21. Only the Good Die Young	4:23	2:52	
Totals	1:40:43	49:15	**Percent Sang:** 49.36%

Minimal vocal issues were noted during the concert, although he is noted to drop the performed keys from the original studio album key. He was also observed to be using a piano teleprompter during the show to remind himself of the lyrics. Joel mentioned using a throat spray during the concert, suggestive of improved attention to vocal hygiene. His performance and vocal energy remained high and consistent. He took his typical one-minute exit prior to the encore. Talking continued to be minimal across all concerts.

This concert was viewed by 89,652 YouTube users who left 59 comments, four of which were negatively related to voice (**Table 6.15**). User BP remarked, *"hmm, at least the roadie is singing the song in the original key"* and T9 replied,

> *What difference does it make? At least he and Elton sing the tunes in a key that they do not have to strain to attain…. Props to Billy and Elton for using common sense. Anyways, if these new keys were the original keys, would you say, uhmmm "would sound better in such and such key"??? Of course NOT!!! The whole complaint about changing keys is a lot to do about nothing!!!"*

User RW remarked on his increased use of a teleprompter, *"He has so much material, he needs a teleprompter…LOL. Great show"* to which user DS replied, *"I guess when you have a million songs to try to remember it helps to have a teleprompter to remind you of the lyrics. I like the one built into his piano".*

Concert 6

The sixth and final concert for Billy Joel was in 2019 and included 25 songs over two hours and three minutes. During this concert his percent sang slightly increased to 51% (**Table 6.20**).

Table 6.20: Singer 2 – Billy Joel – concert 6

Billy Joel	**2019 Concert**		
Set List	Song Length	Total Time Singing ONLY	
1. A Matter of Trust	4:42	2:36	
2. My Life	5:18	2:28	
3. The Entertainer	3:47	2:14	
4. Vienna	3:29	2:09	
5. The Downeaster Alexa	3:36	2:18	
6. Say Goodbye to Hollywood	4:20	2:09	
7. Don't Ask Me Why	3:21	1:58	
8. She's Always a Woman	3:39	2:31	
9. The Ballad of Billy the Kid	5:26	1:57	
10. Movin' Out	3:47	2:03	
11. New York State of Mind	6:40	2:49	
12. Allentown	3:36	2:19	
13. Rule Britannia/We'll Meet again	0:45	0:06	
14. I Go To Extremes	4:04	1:55	
15. Sometimes a Fantasy	3:50	1:52	
16. Only the Good Die Young	4:29	2:29	
17. The River of Dreams/I Feel Fine	7:25	3:46	
18. Nessun Dorma	2:06	0:00	
19. Scenes from an Italian Restaurant	7:52	3:29	
20.Piano Man – Encore Starts Here	5:46	2:35	
21. We Didn't Start the Fire	4:47	2:48	
22. Uptown Girl	3:07	2:24	
23. It's Still Rock and Roll to Me	3:22	1:36	
24 Big Shot	4:25	2:37	
25 You May Be Right/Rock and Roll	5:43	2:33	
Totals	1:49:22	55:41:00	**Percent Sang:** 50.91%

Clinical observations include an overall decrease in vocal quality, timbre, and resonance. Changes were noted to the studio album versions of multiple songs, including *Sometimes a Fantasy, River of Dreams,* and *I Feel Fine.* Less dancing and physical movement was observed during this show and noted as a physical accommodation to performance.

This concert was viewed online by 22,338 fans who left a total of 53 comments (**Table 6.15**). Three of which referenced his age and vocal/performance abilities. User CH remarked, *"What a great performer Billy continues to be, at 70 years old he rocked us for almost 3 hours! Top man with a great set of music! Fabulous, fabulous night!"* and user MD agreed, *"I was there, amazing show! Still rocking it at 70!"* Another user, SG posted,

> *"Thank you for posting! Great quality! What an amazing talent. His charisma and voice in tact at 70. Wow. Saw him once at MSG. He does a residency there once a month- if anyone is visiting NYC, make that one of your stops- you will NOT be disappointed!*

Singer 3 – Steven Tyler

Steven Tyler, the lead singer for Aerosmith, is currently 71 years old with a total of 49 years performing a total of 2.381 shows and 32 tours. The band has recorded 15 studio albums and sold over 150 million records (**Table 6.4**). Six of his concerts (1977, 1988, 2002, 2010, 2013, and 2018) were analyzed for a total of 8 hours and 48 minutes. The selected concerts ranged from one to two hours with a total of 16 to 22 songs. At his early career, percent sang was 38%, mid-career 33.5% and late career was 40.5% (**Table 6.21**).

Table 6.21: Singer 3 – Steven Tyler results

	1st	2nd	3rd	4th	5th	6th
Total Concert Length	1:24:02	1:00:00	1:34:00	2:00:02	1:34:44	1:15:00
Number of Songs	17	22	16	20	20	16
Total Song Time	1:14:10	1:30:37	1:22:32	1:52:24	1:28:30	1:05:56
Total Time Singing	31:36	30:11	29:54	35:06	36:02	26:23
Percent Sang	43%	33%	36%	31%	41%	40%
	Early Career	38%	Mid Career	33.5%	Late Career	40.5%

Aerosmith's genre is hard rock and their frontman, Steven Tyler, is known to have an impressive vocal range with signature vocal screams. Steven has been interviewed describing his singing technique as *Bel Canto*, an Italian style used by opera singers and focusing on vocal hygiene. This has not always been the case as band member, Joe Perry, notes in his autobiography,

> *In March 2006, for example, our national tour was curtailed for another medical emergency. Steven required throat surgery. The issue of Steven's throat was one that had been bothering us for years. He used to say, "you can change guitar strings, Joe, but I can't change vocal cords." "That's true," I'd reply. "So why are you shouting and screaming on your off days? Why aren't you resting your voice?" Time and again, he brushed me off, saying that wasn't the issue. But I knew it was. The problem only got worse when Steven refused to rest his voice. You could never keep him quiet. When he went to the hospital to have a blister on his vocal cords removed, Billie and I were with him the morning of the operation. His doctor said that Steven had a million-in-one voice, a uniquely large voice*

> *box. But even after the successful operation, the pattern didn't stop. His solution was that we'd play fewer gigs, to rest his voice. We were quick to agree. But then he refused to stay quiet on his off days. On top of that, he rarely took advantage of ear monitors that both reduce the volume of the band behind him while enabling him to sing with more dynamics and less strain. This is one of the many tools today's singers have at their disposal to preserve their voices." (p 332-333)*[228]

The band has been open about their history of "sex, drugs, and rock 'n' roll" In his memoir, Tyler mentions using the following drugs: Seroquel, Neurontin, Xanax, Benzodiazepine, Valium, Librium, Cocaine, OxyContin, Lunesta, Suboxone, Dexedrine, Benzedrine, Marijuana, Heroin, Tuinol, Methamphetamine, Seconal, Amyl Nitrate, Laudanum, Quaaludes, Dilaudid, Methadone, Clonidine, LSD, Hashish, Opium.[268] Tyler admits to spending over 20 million on drugs across his career with heavy drinking and attending eight rehabs. He is currently nine years sober and acknowledges the lifestyle change, *"I got a band that's still together, the guys are still alive, everyone's healthy," Tyler said. "We play better than we did 50 years ago."* Joe Perry also commented on this overall change saying, *"As we musicians get older, we need to make adjustments."* (p. 333)[228]

Concert 1

The first concert was in 1977 and included 17 songs over one hour and twenty-four minutes. The percent sang for this early career concert was 43% (**Table 6.22**).

Table 6.22: Singer 3 – Steven Tyler– concert 1

Steven Tyler 1977 Concert			
Set List	Song Length	Total Time Singing ONLY	
1. Back in the Saddle	4:38	2:21	
2. Mama Kin	3:55	2:12	
3. I Wanna Know Why	3:08	1:59	
4. Big Ten Inch Record	2:36	1:16	
5. Three Mile Smile	4:16	1:15	
6. Reefer Head Woman	4:26	1:18	
7. Bone to Bone	2:53	1:23	
8. Walk this Way	3:42	1:26	
9. Dream On	4:41	2:47	
10. Rats in the Cellar	4:27	1:33	
11. Get the Lead Out	3:40	1:52	
12. Remember	5:56	2:32	
13. Lord of the Thighs	7:10	1:31	
14. Same Old Song & Dance	5:42	2:02	
15. Milk Cow Blues	4:51	1:54	
16. Toys in the Attic	3:54	2:09	
17. Come Together	4:15	2:06	
Totals	1:14:10	31:36:00	**Percent Sang:** 42.61 %

Clinical observations noted vocal inconsistencies and pitch breaks, flat notes, increased vocal strain and overall poor vocal quality. Tyler also forgot lyrics across the concert and lacked overall energy. This may be due to the influence of drug/alcohol abuse.

The concert was viewed online by 87,408 fans who left 161 comments, seven of which were negative regarding his voice (**Table 6.23**).

Table 6.23: Singer 6 – Steven Tyler– concert comments

	Total Views	Total Comments	Voice -Positive	Voice -Negative
1977	87,408	161	0	7
1988	116,244	100	3	0
2002	131,077	62	0	0
2010	821	0	0	0
2013	150,721	1	0	0
2018	3,204	5	0	2

User JA noted, *"Man, Tylers voice sounds slightly shot here – but they still play that great rock n roll from the waist."* User MB agreed, *"Steven has a bit of a hard time vocally in 'Saddle'* and D1 said*, "Is it just me or does Steven Tyler's voice sound shot? I thought he sounded a lot better on the Houston show from June of 1977 than he did here."* IN remarked, *"They were all drugged up"* and JF who attended the live show, commented, "*I was there that night - remembering walking out of the arena disappointed. This show had a few good moments in hind sight."* User LC agreed saying, *"Lol what's up with Steven's voice at the back in the saddle chorus? It sounds no Bueno" The most insightful comment came from user 1irishanml.*

> *"Other than some tempo issues, and the typical forgotten lyrics and some flat notes these guys were pretty damn good this night. Considering how many drugs they were taking at this point I'm surprised how good they sound. Aerosmith live at this point could be a disaster. I saw them in 78 and Perry's guitar was so frigging loud, which Tyler always complained about, that you could barely hear Steven singing. Tyler looks like he had some pretty heavy narcotics this night as his voice is cracking at times and*

he's not as energetic as he usually is. I don't think that Aerosmith understood a lot of young fans were seeing them for the first time at these shows and instead of hearing Tyler and the guys playing what was on the album, you had Tyler singing higher than he did on the first three records as Douglas wanted him to sing like that. You had Tyler scatting and forgetting lyrics so it was not what the fans were listening to at home. The first time I heard him scatting I was like wth is he doing to this song and then when he forgot lyrics I was just like man they are sucking. After you get past Tyler's wasted mistakes and Perry's horribly loud guitar they were amazing. To this day Tyler still makes mistakes live but boy they sound better than they ever did in the 70's."

Concert 2

The second concert analyzed was in 1988 and consisted of 22 songs over one hour. Tyler had an increase in percent sang to 33% for this concert (**Table 6.24**).

Table 6.24: Singer 3 – Steven Tyler– concert 2

Steven Tyler 1998 Concert			
Set List	Song Length	Total Time Singing ONLY	
1. Toys in the Attic	4:58	1:14	
2. Same Old Song	5:24	1:37	
3. Big Ten Inch Record	3:50	0:58	
4. Dude Looks Like	4:21	1:37	
5. Lightning Strikes	4:45	1:42	
6. Rag Doll	3:54	2:15	
7. Hangman Jury	5:46	3:00	
8. Permanent Vacation	4:16	1:54	
9. Angel	5:18	2:57	
10. Back in the Saddle	4:13	1:09	
11. *Brad Whitford Solo Guitar*	1:52		
12. Last Child	3:13	1:16	
13. *Joe Perry Solo Guitar*	2:40		
14. Draw the Line	4:42	1:19	
15. One Way Street	2:05	0:50	
16. Dream On	4:44	2:42	
17 Train Kept a Rollin	4:40	1:14	
18. *Joey Kramer Solo Drums*	9:12		
19. Sweet Emotion	4:29	1:16	
20. *Peter Gunn Theme Guitar*	3:18		
21. I'm Down	2:11	1:48	
22. Walk This Way	3:46	1:23	
Totals	1:30:37	30:11:00	**Percent Sang:** 33.31 %

Clinical observations include improved vocal quality compared to previous concert with the use of falsetto scream on *Draw the Line*. Harmonica was incorporated during several songs (*Hangman Jury, Permanent Vacation, and Big Ten Inch Record).* Physical energy was high with various activities such as Tyler riding the microphone stand around the back of the stage in *Back in the Saddle*. It is noted that this concert was during one of the many times that the band was currently sober.

This concert was viewed 116,224 times with 100 comments left by viewers who were more positive with this show (**Table 6.23**). Viewer CT noted, *"Tyler's voice is* *much better at that time than in the previous years"* and user CK remarked, *"I agree Steven Tyler's voice is awesome here! The band just go cleaned up here and you can tell in a good way!"* Viewers were surprisingly insightful into the impact of the drug use on the singer's performance,

> *"The thing that jumps out to me, was that in nearly all the clips from the late 70's until just before this tour, Steven never smiled on stage. He largely looked miserable. Once he got sober the joy came back to him and his stage persona completely changed. So great they survived"* (user JP).

There were no negative vocal or performance related comments for this show.

Concert 3

The third concert was in 2002 where Aerosmith played 16 songs over one hour and thirty-four minutes. This mid-career concert had a slight increase in percent sang to 36% (**Table 6.25**).

Table 6.25: Singer 3 – Steven Tyler– concert 3

Steven Tyler	**2002 Concert**		
Set List	Song Length	Total Time Singing ONLY	
1. Toys in the Attic	4:58	1:14	
2. Back in the Saddle	5:24	1:37	
3. Same Old Song	3:50	0:58	
4. Girls of Summer	4:21	1:37	
5. Sweet Emotion	4:45	1:42	
6. What it Takes	3:54	2:15	
7. Lord of the Thighs	5:46	3:00	
8. I Don't Wanna Miss a Thing	4:16	1:54	
9. Monkey on My Back	5:18	2:57	
10. Jaded	4:13	1:09	
11. Pink	1:52		
12. Stop Messing (Joe Perry lead)	3:13	1:16	
13. Cryin'	2:40		
14. Dude	4:42	1:19	
15. Draw the Line	2:05	0:50	
16. Walk this Way	4:44	2:42	
Totals	1:30:37	30:11:00	**Percent Sang:** 36.23 %

This concert included the use of reverb, Tyler's characteristic falsetto on *Draw the Line*, and scat singing/screaming on *Monkey* and *Draw.* The use of harmonica continued on *Pink, Stop Messing* (Joe Perry sang lead), and *Cryin'.* Run DMC and Kid Rock joined the band and sang verses of *Walk this Way*. Tyler's vocals were overall consistent, although not as strong as the last concert.

This concert was viewed by 131,077 people who left 62 comments (**Table 6.23**). None of the comments were relevant to voice/performance related issues.

Concert 4

The fourth concert was in 2010 and consisted of 20 songs over 2 hours. The percent sang dropped to 31% (**Table 6.26**).

Table 6.26: Singer 3 – Steven Tyler–concert 4

Steven Tyler **2010 Concert**			
Set List	Song Length	Total Time Singing ONLY	
1. Eat the Rich	4:58	1:14	
2. Love in an Elevator	5:24	1:37	
3. Falling in Love	3:50	0:58	
4. Pink	4:21	1:37	
5. Dream On	4:45	1:42	
6. Livin on the Edge	3:54	2:15	
7. Jaded	5:46	3:00	
8. Cryin	4:16	1:54	
9. *Drum Solo*	5:18	2:57	
10. Lord of the Thighs	4:13	1:09	
10. Rag Doll	1:52		
11. What it Takes	3:13	1:16	
12. Sweet Emotion	2:40		
13. Stop Messing	4:42	1:19	
14. Last Child	2:05	0:50	
15. Baby Please	4:44	2:42	
16. Draw the Line	4:40	1:14	
17. *Break for Encore*	9:12		
18. Crazy	4:29	1:16	
19. Walk	3:18		
20. Train	2:11	1:48	
Totals	1:30:37	30:11:00	**Percent Sang:** 33.31 %

Minimal talking between songs is consistent with all other shows. Performance antics increased with Perry almost falling into the audience and Tyler spitting into the audience during *Eat the Rich.* Tyler used acapella and falsetto on *What it Takes* and falsetto on *Last Child.* He did not play the piano during *Dream On.* He also used a strange breath pattern for *Living on the Edge.*

This concert had a mere 821 views with 0 comments (**Table 6.23**).

Concert 5

The fifth concert was in 2013 and Aerosmith played 20 songs over one hour and thirty-four minutes. This late career concert saw an increase in percent sang to 41% (**Table 6.27**).

Table 6.27: Singer 3 – Steven Tyler– concert 5

Steven Tyler	**2013 Concert**		
Set List	Song Length	Total Time Singing ONLY	
1. Back in the Saddle	5:40	1:53	
2. Elevator	6:30	2:11	
3. Just Push Play	4:12	2:06	
4. Ole Ole	0:10	0:10	
5. Jaded	3:21	1:59	
6. Mama Kin	4:51	1:57	
7. Pink	3:58	2:31	
8. Girls of Summer	3:20	2:26	
9. *Stop Messing (perry as lead)*	4:54	0:23	
10. Dream On	4:41	2:27	
11. Draw the Line	6:12	1:40	
12. Don't Wanna Miss	4:17	2:44	
13. Cryin'	5:05	2:33	
14. Walk this Way	3:55	1:20	
15. Outside my Window	1:21	0:34	
16. Sweet Emotion	5:59	1:22	
17. Spider Man	3:46	1:02	
18. What it Takes	5:12	3:26	
19. Livin' on the Edge	5:36	2:39	
20. Train Keeps Rollin'	5:30	0:39	
Totals	1:28:30	36:02:00	**Percent Sang:** 40.72 %

Total talking time was under one minute. Harmonic use continued on several songs (*Pink, Stop Messing, and Train Keeps Rollin').* Joe Perry sang lead on *Stop Messing*. Tyler spoke one line in *Dream On* that is usually sung. He had the audience sing some of the "walks" during *Walk this Way*. Tyler performed acapella on the first and second verses of *What it Takes* and used higher notes on the second verse. The opening act singer returned to sing the first verse of *Train Keeps Rollin.* Overall, his voice and performance level were consistent with previous years.

The concert was viewed by 150,721 users with only one comment left that was not relevant to this study (**Table 6.23**).

Concert 6

The sixth and final concert was in 2018 and included 16 songs over one hour and fifteen minutes. Percent sang dropped slightly to 40% (**Table 6.28**).

Table 6.28: Singer 3 – Steven Tyler– concert 6

Steven Tyler	**2018 Concert**		
Set List	Song Length	Total Time Singing ONLY	
1.*Movie Intro*	1:55		
2. Sweet Emotion	5:31	1:19	
3. Cryin	4:52	2:14	
4. I'm Down/Oh Darlin	2:26	1:11	
5. Come Together	3:55	1:38	
6. Rattlesnake	2:35	0:40	
7. Jaded	3:36	1:44	
8. Only Heaven	3:22	2:09	
9. Mercedes Benz	1:25	0:40	
10. Piece of my Heart	4:02	2:03	
11. We're all Somebody	4:37	2:05	
12. Livin on the Edge	6:08	2:23	
13. Janie's got a Gun	4:35	2:54	
14. Home Tonight/Dream On	4:27	2:11	
15. Train Kept Rollin	6:56	1:06	
16. Walk this Way	4:21	1:49	
17. Whole Lotta Love	1:13	0:17	
Totals	1:05:56	26:23:00	**Percent Sang:** 40.02 %

Clinical observations noted that Tyler only sang half of the “sweets” on *Sweet Emotion* and forgot the lyric. He had the crowd sing half of the “walks” on *Walk this Way.* The guitarist doubled the high notes on *Mercedes Benz* and also sang in *Jaded.* He continued the breathing pattern on *Living on the Edge* as the last two concert and played a bongo solo during the show. His voice overall, remained consistent across the concert. Total talking time was at 72 seconds.

This concert was watched online by 3,204 viewers and a total of five comments were left (**Table 6.23**). User IE posted, “Steven be turning songs out every time!” and LT commented, “Steven had an error on “Sweet Emotion”.

Singer 4 – Elton John

Elton John is currently 72 years old and has been performing for 51 years for an incredible total of 3,894 shows and 59 tours. He has recorded 30 studio albums and sold over 300 million records (**Table 6.4**). Six of his concerts (1974, 1989, 2001, 2010. 2015, and 2018) were analyzed for a total of 11 hours and 44 minutes. The selected concerts ranged from 10 to 24 songs with a total concert time between one hour and one minute to two hours and thirty-three minutes. At his early career point, his total percent sang was 65.5%, mid-career was 71.5% and late career is 77% (**Table 6.29**).

Table 6.29: Singer 4 – Elton John results

	1st	2nd	3rd	4th	5th	6th
Total Concert Length	1:01:11	2:10:00	2:02:00	1:55:00	2:03:00	2:33:00
Number of Songs	10	21	20	19	21	24
Total Song Time	46:21	1:46:00	1:43:10	1:32:17	1:46:20	2:03:25
Total Time Singing	28:18	1:13:43	1:10:48	1:08:16	1:26:45	1:27:40
Percent Sang	61%	70%	69%	74%	83%	71%
	Early Career	65.5%	Mid Career	71.5%	Late Career	77%

This reflects an increase in percent sang over his career at the selected points with a drop noticed by his sixth concert.

Elton's vocal genre is pop/rock and he also has made a career out of his virtuoso piano abilities. He underwent vocal surgery early in his career (1987) for an exploratory procedure and had vocal quality changes following when he returned to perform. *"My voice is the thing that's really improved the most over the last few years. There's more resonance to it. It started to change when I had the operation in Australia after the live album, because of the nine cancerous…whatever it was on my vocal cords"* he told *Billboard* in 2004. He acknowledged the loss of his "full falsetto" following that time, but states that he did not drop his catalog of music and continues to do it in the original key. Elton also has candidly discussed his struggles with alcohol, drugs, and bulimia and discussed this in an interview with Piers Morgan in 2010, "*This is how bleak it was: I'd stay up, I'd smoke joints, I'd drink a bottle of Johnnie Walker and then I'd stay up for three days and then I'd go to sleep for a day and half, get up, and because I was so hungry, because I hadn't eaten anything, I'd binge and have like three bacon sandwiches, a pot of ice cream and then I'd throw it up, because I became* bulimic and then go and do *the whole thing all over again…And I'm not being flippant when I say that, when I look back I shudder at the behavior and what I was doing to myself."* Elton became sober in 1990 and worked to develop healthy vocal habits. He continued the *Billboard* interview to say, *"Halfway through my career I got a voice change, thanks a lot! And I've learned to breathe properly, I've watched other people singing, I've become a much better singer. I've become a singer that plays the piano instead of a piano player that sings".*

Concert 1

The first concert analyzed was in 1974 where Elton sang 10 songs over an hour and one minute. His total percent sang for this concert was 61% (**Table 6.30**).

Table 6.30: Singer 4 – Elton John – concert 1

Elton John	**1974 Concert**		
Set List	Song Length	Total Time Singing ONLY	
1. Benny and the Jets	5:45	2:18	
2. Lucy in the Sky with Diamonds	5:27	3:33	
3. I saw her standing there	2:45	1:47	
4. Don't Let the Sun Go Down on Me	6:05	4:01	
5. Honky Cat	6:17	3:17	
6. Saturday Night's alright for fighting	7:15	3:39	
7. Crocodile Rock	3:18	1:34	
8. The Bitch is Back	3:43	2:44	
9. Your Song	2:20	1:37	
10. I'm Dreaming of a White Christmas	3:36	3:48	
Totals	0:46:21	28:18:00	**Percent Sang:** 61.06%

This was an unedited live tv concert. During the concert Elton was very physical, constantly jumping up and down, often while he was playing piano and singing. It was observed that he had something on hand to drink when he needed it. Although this was

13 years before his vocal surgery, he was noted to have vocal deterioration toward the end of the concert characterized by losing his upper register and increased strain with upper notes.

This concert has been watched by 666,273 users who left a total of 492 comments (**Table 6.31**).

Table 6.31: Singer 4 – Elton John – concert comments

	Total Views	Total Comments	Voice -Positive	Voice - Negative
1974	666,273	492	3	10
1989	1,397	0	0	0
2001	1,670,934	393	4	2
2010	89,951	22	0	1
2015	852,737	355	7	2
2018	55,309	82	3	5

Three were positive regarding voice and performance and 10 were negative. User BD said,

> *"This is just an awesome recording of a very young Elton with his now famous band. The voice is strong and is at its peak. We're so lucky to have this on video and for us to enjoy 24/7/365. Amazing that he still performs at this very high level. Saw him several months back in Boston. A truly magnificent performance for well over 2:45 hours. He is still so humble and adores the audience. He gets up from the piano and thanks every corner of the stadium/music hall after nearly every song. To have that much energy and devotion after so many years is mind boggling.*

> *Every concert he treats it like it's his first/last of his career. No other performer/artist even comes close."*

Another user, JT, wrote, "*Wow. Elton in his prime"* and P1 commented, *"He's not a natural dancer but man he has presence."* Another viewer, AF stated, *"…and the versatility in that voice is insane. Love him!"*

Other users compared his current sound to this historical video. MP wrote,

> *"I saw him the month before this on Nov. 20 1974. in Boston. He was amazing. There was no one better at the time, and as time passes although older and losing his brilliant voice he still gets out there and performs. He was and is the greatest and I don't know what my life would have been like without his musical genius.*

FD wrote, *"He still has a magnificently powerful voice"* and SW remarked, *"The brilliant, youthful voice. Aging…sigh".* Another user, DH stated, *"This was the year I discovered Elton and have been a fan ever since. His voice has evolved, and he's lost some of it over the years, but in the 70s, he had the voice of an angel. It was elastic and beautiful. There are NO vocalists in "modern" bands with this kind of a one-of-a-kind voice."* P2 said, *Wow, his voice has changed a lot nowadays"* and KH agreed, *"This is the Elton John I fell in love with as a kid…a far cry from what he is today."* User JI remarked, *"If only he sounded this good now…"* and S2 wrote,

> *"I've never seen him perform to where he actually sounds like on the yellow brick road album. To me he sounds totally different now. And yes, I realize he's getting quite old now, But, to be honest I can't think of*

another artist whose voice has changed so drastically over the years. It's so low now w/ almost a different delivery. This is the Elton I like. Great upload. Thx".

Concert 2

The second concert was in 1989, after Elton's vocal surgery. He performed 21 songs over two hours and ten minutes. His percent sang for this concert increased to 70%, a 9% increase compared to the last concert (**Table 6.32**).

Table 6.32: Singer 4 – Elton John – concert 2

Elton John 1989 Concert			
Set List	Song Length	Total Time Singing ONLY	
1. Sixty Years On	1:35	0:46	
2. I Need You to Turn To	2:29	1:47	
3. The King Must Die	4:46	3:16	
4. Burn Down the Mission	5:37	3:41	
5. Sorry Seems to Be the Hardest Word	3:38	2:35	
6. Have Mercy on the Criminal	5:38	3:57	
7. Funeral for a Friend/Love Lies Bleeding	7:21	2:13	
8. I Guess That's Why They Call it the Blues	3:43	3:01	
9. Philadelphia Freedom	5:00	3:57	
10. Sad Songs	6:28	4:33	
11. Kiss the Bride	3:12	2:47	
12. A Word in Spanish	5:04	4:32	
13. Mona Lisas and Mad Hatters	5:20	2:21	
14. Mona Lisas and Mad Hatters part two	4:57	2:31	
15. Nikita	6:13	5:32	
16. Daniel	4:37	3:03	
17. I Don't Wanna Go on With You Like That	6:05	5:47	
18. Candle in the Wind	4:06	3:38	
19. Saturday Nights Alright	7:02	4:41	
20. Rocket Man	6:45	4:45	
21. Your Song	6:33	4:20	
Totals	1:46:00	1:13:43	**Percent Sang:** 69.54%

During this concert, he was noted to still struggle with the upper register. His voice was heavier in the lower register with better resonance. Performance energy remained high and consistent with the last concert.

This concert was viewed by 1,397 people and no comments were left (**Table 6.2**).

Concert 3

The third concert point was in 2001where Elton sang 20 songs over two hours and two minutes. The percent sang for this concert was 69% (**Table 6.33**).

Table 6.33: Singer 4 – Elton John – concert 3

Elton John 2001Concert			
Set List	Song Length	Total Time Singing ONLY	
1. Your Song	5:47	4:47	
2. Someone Saved my Life Tonight	6:20	4:01	
3. Daniel	4:49	4:29	
4. Mona Lisas and Mad Hatters	5:07	3:01	
5. Honky Cat	6:12	3:21	
6. Rocket Man	7:20	3:39	
7. Philadelphia Freedom	6:04	4:54	
8. Nikita	5:56	3:49	
9. Sacrifice	4:03	3:21	
10. Sorry Seems to be the Hardest Word	4:44	3:49	
11. I Guess That's Why They Call it the Blues	5:04	3:39	
12. This Train Doesn't Stop There Anymore	4:33	3:56	
13. Burn Down the Mission	8:56	4:02	
14. The One	6:19	3:13	
15. Blue Eyes	3:49	2:47	
16. I’m Still Standing	3:45	3:21	
17. Crocodile Rock	3:50	4:09	
18. Don't Let the Sun Go Down On Me	4:41	3:57	
19. Circle of Life	4:19	1:18	
20. Candle in the Wind	1:32	1:15	
Totals	1:43:10	1:10:48	**Percent Sang:** 68.63%

Clinical observations of singing include missing upper notes during *Rocketman.* His upper range continued to be strained (e.g, *Someone Saved My Life Tonight).* For this concert, he sat at the piano and simply performed compared to the physicality of his younger years.

This concert was viewed by 1,670,934 people who left a total of 393 comments, four of which were relevant to this study (**Table 6.31**). Overwhelmingly, the viewers were positive about his performance during this concert. Viewer LB stated, *This is what pure talent looks like"* and KS wrote*, "1:19:10 - wow! falsetto after the vocal surgery?"* User CP remarked, *"1997-2003 was his prime. Baritone voice…sober for a decade. He sounds amazing. Decline started around 2009 he was still by most standard amazing."* Several users compared this concert to today, "*His range these days is more limited than in 2001 here, but that's just aging. This Man is 71 and still a hell of a singer and piano player, sounds a lot better than others at his age. Looking forward to see him one last time live."* (user R1). MY wrote, *"I wouldn't even say he went baritone until 1999. 1997-1998 was his strongest post-surgery performance era (it's full of falsettos, high notes, and sustained notes)."*

Concert 4

The fourth concert was in 2010. Elton sang 19 songs over one hour and fifty-five minutes. His percent sang for this mid-career concert increased to 74% (**Table 6.34**).

Table 6.34: Singer 4 – Elton John – concert 4

Elton John 2010 Concert			
Set List	Song Length	Total Time Singing ONLY	
1. Funeral for a Friend/Love Lies Bleeding	9:30	2:30	
2. Saturday Night's Alright for Fighting	5:07	4:49	
3. Levon	4:00	3:43	
4. Tiny Dancer	5:44	4:37	
5. Philadelphia Freedom	4:49	4:13	
6. Goodbye Yellow Brick Road	3:15	2:52	
7. Daniel	4:32	3:52	
8. Rocket Man	8:04	4:34	
9. I Guess That's Why They Call it the Blues	5:35	3:56	
10. Take Me to the Pilot	6:12	3:59	
11. Sacrifice	3:41	2:57	
12. Don't let the Sun Go Down On Me	4:45	4:03	
13. Sorry Seems to be the Hardest Word	3:21	2:56	
14. Bennie and the Jets	6:21	4:45	
15. The Bitch is Back	4:30	4:01	
16. I'm Still Standing	3:09	2:47	
17. Crocodile Rock	4:40	3:01	
18. Candle In the Wind	2:02	1:57	
19 Your Song	3:00	2:44	
Totals	1:32:17	1:08:16	**Percent Sang:** 73.98%

Clinical observations include a continued strained upper range that appeared to fatigue with use. Lots of voice breaks were noted with a tendency to favor a lower vocal register and lower keys for songs. He eliminated the high notes for *Tiny Dancer*. His performance continued to be limited in movement, generally staying behind the piano without any grand movements.

This concert was viewed by 89,951 fans who left 22 total comments (**Table 6.31**). One user (ES) remarked, *"Must be the last time I've heard him do the "born" high notes in Philadelphia Freedom"* and user RC wrote, *"Elton, please die, finally!"*

Concert 5

The fifth concert point was in 2015 where Elton performed 21 songs for a total of two hours and three minutes. The total percent sang increased to an impressive 83% at this late career concert (**Table 6.35**).

Table 6.35: Singer 4 – Elton John – concert 5

Elton John 2015 Concert			
Set List	Song Length	Total Time Singing ONLY	
1. The Bitch is Back	4:20	3:37	
2. Bennie and the Jets	7:20	5:14	
3. Candle in the Wind	4:01	3:49	
4. All the Girls Love Alice	4:48	3:38	
5. Levon	9:39	7:14	
6. Tiny Dancer	6:18	5:45	
7. Daniel	3:30	3:03	
8. Philadelphia Freedom	4:49	4:25	
9. Goodbye Yellow Brick Road	3:04	2:55	
10. Rocket Man	5:11	3:30	
11. Hey Ahab	5:15	4:44	
12. I Guess That's Why They Call it the Blues	5:02	4:49	
13. Your Song	3:31	3:15	
14. Burn Down the Mission	5:51	4:40	
15. Sad Songs	4:35	3:36	
16. Sorry Seems to be the Hardest Word	3:15	3:03	
17. Don't Let the Sun Go Down On Me	6:30	5:31	
18. I'm Still Standing	3:05	2:47	
19. Your Sister Can't Twist	4:20	4:01	
20. Saturday Night's Alright for Fighting	7:13	3:04	
21. Crocodile Rock - Encore	4:43	4:05	
Totals	1:46:20	1:26:45	**Percent Sang:** 81.62%

His vocal strength was improved at this concert, sounding better than his younger and mid-career concerts. He experienced some vocal roughness midway through the concert. Elton continued to have difficulty with upper range but routinely dropped higher notes and keys to better fit his voice.

This concert has 852,737 views and users left 355 comments with seven positive and two negative comments relevant to this study (**Table 6.31**). User JJ wrote, *"This man is AMAZING!!!! The extended piano solo during Levon left me mesmerized by his immense talent and stamina. Holy cow, Elton.. you still got it!"* R1 *"And his voice is like a good old scotch... getting better with aging"* PG wrote, *"Seen him a few years back, when he was doing his Vegas stint. The thing that impresses me most about Sir Elton, is his longevity, while maintaining his voice all these years!"* User IB remarked, *"My favorite concert I've seen online of his! He looks awesome and sounds great! You can tell he's aged a lot in last two years, being sick and all."* R1 replied to a comment saying, *"Going to see him again during his final tour. Bittersweet but he's 73 when this tour ends. Maybe It's a good time to retire to keep his legacy. Look at other Legends. McCartney can't stop it at 77 and his voice is completely gone these days. I don't wanna see my Elton doing this."* A user named EJ wrote, *"Watching this shows he really hasn't lost it and is going to keep on going, can't wait to see him in the summer..."* Not all comments were positive, with user SG writing, *"he looks and dresses like my grandmother"* and CM remarking, *"So amazing. I saw my first show in 2013 and I was absolutely floored. His voice isn't what it once was, but in the range that he does hit he hits the notes with power and soul that I'd say is even better in some ways."* Finally, MD wrote, *"I noticed how raspy his voice was getting halfway through the concert. he got better as the show went on and yes SNAFF and croc rock was the highlight."*

Concert 6

The final concert point was in 2018 and included 24 songs over two hours and thirty-three minutes. At this concert, his percent sang dropped 12% to 77% (**Table 6.36**).

Table 6.36: Singer 4 – Elton John – concert 6

Elton John 2019 Concert			
Set List	Song Length	Total Time Singing ONLY	
1. Bennie & the Jets	5:35	3:59	
2. All the Girls Love Alice	4:52	3:48	
3. I Guess That's Why They Call it the Blues	4:25	4:01	
4. Border Song	3:06	2:58	
5. Tiny Dancer	6:07	5:41	
6. Philadelphia Freedom	4:49	4:12	
7. Indian Sunset	6:44	3:02	
8. Rocket Man	8:25	4:03	
9. Take Me to the Pilot	3:55	3:13	
10. Someone Saved My Life Tonight	6:24	5:13	
11. Levon	12:31	3:55	
12. Candle in the Wind	4:40	4:14	
13. Funeral for a Friend/Love Lies Bleeding	9:11	2:56	
14. Burn Down the Mission	6:15	3:04	
15 Daniel	3:53	3:24	
16. Believe	3:59	3:47	
17. Sad Songs	4:25	3:59	
18. Don't Let the Sun Go Down on Me	5:07	4:31	
19. The Bitch is Back	1:22	3:23	
20. I'm Still Standing	3:04	2:55	
21. Crocodile Rock	3:56	3:21	
22. Saturday Night's Alright for Fighting	3:46	2:34	
23. Encore - Your Song	3:59	3:13	
24 Goodbye Yellow Brick Road	2:55	2:14	
Totals	2:03:25	1:27:40	**Percent Sang:** 71.03%

His voice was strong for this concert, although not as clear as the 2001 concert. The concert was viewed by 55,309 fans who left 82 comments, three were positive and five were negatively related to this study (**Table 6.31**). User JC wrote, "Elton is so incredibly consistent in his performance. Amazing" and user DG wrote, "Great singer/artist/voice/music." KC commented, *"No one beats sir Elton and Billy Joel in piano effortlessness and distinctive voices. Except Billy wrote his own songs. I'm a bit shitty with Elton charging $2500 for VIP tix in Australia!!"* Not everyone was happy with this concert as user HO wrote, *"I was on here! Great, seeing you Elton! It was bloody boring! He keeps doing the same thing in every fucking live concert for the last (50 + years). People want surprises sometimes. It's time to really retired that "effing piano" Have a happily, peacefully retirement!"* and JP remarked, *"My dad hates him just because he doesn't have the same voice... just appreciate the music."* AG wrote, *"Looks like a tired Russian Babushka, how can people write it was so great? Get off the stage please.*" User AD pokes fun at Elton's habit of announcing a retirement multiple times across his career, *"Elton John has announced he is retiring... In 3 years.. after a 300 date tour".* SB commented, *"Poor Elton, his voice has gone since a long time...he was the king in the seventies..."* User DV wrote, *"I just found out that Elton had surgery on his throat in the 1980's. That's why he sounds like an entirely different person today! Apparently, he thinks he sounds better than before his surgery. Personally, I find his voice uninspiring and rather ordinary now. Much better in the god ol' days, and for this reason I will not be going to his farewell concert."* User TD remarked, *"let's get real... he sounds TERRIBLE. No going back to the old Elton."*

Singer 5 – Rod Stewart

Rod Stewart is currently 74 years old and has been performing for a total of 54 years and 2,236 shows. He has recorded 31 studio albums and sold 120 million records (**Table 6.4**). Six of his concerts (1984, 1980, 1991, 2008, 2012, and 2018) were analyzed for a total of eight hours and fifty-three minutes. The selected concerts ranged from 10 to 22 songs with a total concert time ranging from one hour one minute to one hour fifty-three minutes. At his early career, percent sang was 36%, mid-career percent sang was 46.5% and late career percent sang was 41% (**Table 6.37**).

Table 6.37: Singer 5 – Rod Stewart results

	1st	2nd	3rd	4th	5th	6th
Total Concert Length	1:03:00	1:01:00	1:53:00	1:24:00	1:46:00	1:46:00
Number of Songs	13	10	22	18	19	22
Total Song Time	59:49	58:58	1:36:22	1:18:06	1:27:01	1:36:52
Total Time Singing	17:08	25:20	44:53	36:04	35:44	39:41
Percent Sang	29%	43%	47%	46%	41%	41%
	Early Career	36%	Mid Career	46.5%	Late Career	41%

Rod's genre is soft rock/pop and he is a singer who has made a career out of having a rough vocal quality. Rod also has a history of illicit drug use (heavy cocaine use) and vocal issues that he documented in his book, *Rod: The Autobiography.*

> *"Night after night I was forcing my voice to compete with that volume, and by the end of the show I had very commonly blown my throat out. The next day, I would walk around feeling as though I had been gargling barbed wire. Then it would get to 6: 00 P.M., two hours before*

the next show, and I would realize that I simply didn't have a voice to sing with. The solution was not a particularly healthy one: I started taking steroids. Prednisone tablets, to be precise. I took them intermittently at first, but by the time the 1980s ended I would be well on my way to developing an addiction to them. Steroids make you hungry, they keep you awake, they cause your cheeks to bloat … but they make you sing like a bird. Good old steroids, then. Except not."[212]

Rod continued to experience severe vocal issues through the 80s and into the 90s, cancelling many shows due to severe voice loss. His overuse of steroids, first oral and then injectables, to try to help save his voice led to a GI bleed in March of 1991 that caused him to realize it was time to make a change. *"In the longer term, it was clear that a blood transfusion alone… wasn't going to save my career as a performer. And neither were steroids. Fortunately for me, technology intervened."* Rod begins to use in-ear monitors to help him avoid over singing and things went well until May of 2000 when he needed a thyroid biopsy for what turned out to be thyroid cancer. Following surgical excision of the tumor, Rod realized his voice was gone.

"So, what if the voice I got back was a different voice? What if the voice I got back was the voice of— for example— a not very good singer? I didn't want any old voice back. I wanted my voice back. Rest for three months was all the doctors could say, and see what happens. Never mind the singing; it was several weeks before I could even talk in anything other than a scratchy whisper. My voice had always had a rasp to it. Now it was nothing but a rasp. As for singing, three months went by and I still

> *couldn’t do it. Not a note. Four months, five months … nothing. I opened my mouth and all that came out was a thin, weak, sandpapery sound—colorless, without tone. These were some of the longest weeks of my life. I would wake up in the morning and think, “Well, maybe today there will be a difference I can notice.” And then, heart-sinkingly, no change. Hadn’t they said three months? Before long I was up to six and I still couldn’t sing.”*[269]

After six months of minimal improvement and significant frustration and the lack of options provided aside from simply waiting, Rod sought out the expertise of a cantor at his synagogue and began working with him to retrain his voice. Through consistent practice he was able to regain vocal stamina and control. This experience forced him to realize that the end may come at a time that he did not choose. “*I am under no illusions. I know that one day it will come to an end. I know that eventually— and it may be sooner, rather than later— I will reach a stage where getting out there and performing is simply no longer possible. And I don’t know how I’m going to feel about that. It’s been there all my life. I’ve given so much to it, and it’s given so much back to me. I worry about the hole it will leave.”*[212] Rod was able to begin performing again and has be able to avoid any further severe vocal issues.

Concert 1

The first concert analyzed was in 1974 when Rod was the frontman for the band, Faces. This concert was the final concert before the band disbanded and Rod went solo. He sang 13 songs during an hour and three minutes. His percent sang for this concert was 29% (**Table 6.38**).

Table 6.38: Singer 5 – Rod Stewart – concert 1

Rod Stewart	**1974 Concert**		
Set List	Song Length	Total Time Singing ONLY	
1. Take a Look at the Guy	4:20	1:51	
2. Bring it on Home to Me	4:09	1:07	
3. You Send Me	4:28	1:30	
4. Sweet Little Rock & Roller	5:45	2:07	
5. I'd Rather Go Blind	6:09	1:24	
6. Angel	5:22	1:50	
7. I Can Feel the Fire	4:50	1:16	
8. You Can Make Me Dane	5:57	2:11	
9. Twisting the Night Away	7:01	1:57	
10. You Wear It Well	6:30	1:11	
11 Maggie May	5:07	:33	
12. We'll Meet Again	:11	:11	
Totals	59:49:00	17:08	**Percent Sang:** 28.64%

Observations of this concert included a very athletic performance by Rod with him dancing with and carrying the mic stand around the stage and lots of his signature move of facing the back of the stage and shaking his hips at the audience. He sang *Take a Look at the Guy* in unison with a band member and had the crowd sing on multiple songs (*Bring it on Home to Me, Angel,* and *Maggie May)* while he just danced. His voice was consistent across the concert.

This concert was viewed by 1,034,872 users who left 816 comments (**Table 6.39**).

Table 6.39: Singer 5 – Rod Stewart – concert comments

	Total Views	Total Comments	Voice -Positive	Voice - Negative
1974	1,034,872	816	3	4
1980	71,346	16	0	0
1991	2,661	0	0	0
2008	1,258,875	171	1	2
2012	310,327	58	0	9
2018	24,503	34	6	8

Only three comments were regarding voice with several more about his performance skills. One young viewer wrote, *"I'm 28, and I had no idea Rod Stewart was once awesome. I only heard his 80s/90s stuff growing up in my parents' house. But this shit is awesome rock and roll!"* (GP) and user MO wrote, *"This was the best time ever. I loved the faces and wished so much that they would have stayed together. Their concerts were like a party, the atmosphere was amazing, there was nothing that could beat it. . . Rod's voice was powerful, gutsy, strong and very sexy. I grieve for the young Rod Stewart. . . Sadly he has lost that powerful, gutsy voice. . .His concerts today are still very enjoyable, mainly because I'm trying to relive that exciting youth, as I suspect many of his fans are. But the concerts these days are too polished, with not much if any surprise."* ZT enjoyed the unenhanced performance commenting, *"No compression, no pitch bend, no auto-tune - just pure old kick ass rock and roll."* Several viewers were judgmental about Rod's appearance, vocal abilities, and performance skills. *"Rod looks like a curtain drape, lucky he can sing"* (user PS). Another viewer, JM, wrote, *"Rod Stewart before he thought he was a lounge singer. His 3 note range and throat cancer vocals really accentuate the orchestra...* BW remarked, *"There may be a difference between* *sensationalism and pure talent. What he excels in talent, he lacks in showmanship"* and user JC agreed, *"Don't get me wrong I love the guy, he guided my life but Rod was awkward on stage"*.

Concert 2

The second concert was in 1980 and consisted of 10 songs over one hour and one minute. The total percent sang increased slightly to 43% (**Table 6.40**).

Table 6.40: Singer 5 – Rod Stewart – concert 2

Rod Stewart 1980 Concert			
Set List	Song Length	Total Time Singing ONLY	
1. Hot Legs	5:12	2:08	
2. Born Loose	4:50	1:34	
3. Tonight's the Night	4:01	2:26	
4. She Won't Dance With Me	5:21	2:09	
5. You're in My Heart	4:09	2:52	
6. If Loving You is Wrong	5:31	3:28	
7. I Know I'm losing You	10:31	1:56	
8. Maggie May	6:41	3:11	
9. Da You Think I'm Sexy	6:58	3:35	
10. Sweet Little Rock N Roller	5:44	2:01	
Totals	58:58:00	25:20:00	**Percent Sang:** 42.96%

This was an unedited TV recorded concert. Rod's voice was rough and raspy consistently across the concert. His athleticism and signature move continued to be at a high level. This concert was viewed by 71,346 users who left 16 comments (**Table 6.39**). None of the comments were relevant to this study.

Concert 3

The third concert was in 1991, seven months after his traumatic GI bleed from steroid abuse and when he reports starting to be more concerned about his vocal health. He sang 22 songs over one hour and 53 minutes. The percent sang for this mid-career concert was the highest of his six, at 47% (**Table 6.41**).

Table 6.41: Singer 5 – Rod Stewart – concert 3

Rod Stewart 1991 Concert			
Set List	Song Length	Total Time Singing ONLY	
1. Maggie May	4:34	2:45	
2. Rhythm of my Heart	3:45	2:26	
3. Sweet Little Rock & Roller	4:35	2:06	
4. Some Guys have All the Luck	5:09	2:26	
5. Downtown Train	4:39	2:36	
6. Lost in You	7:48	4:13	
7. Tonight's the Night	4:34	1:54	
8. Hot Legs	4:05	2:13	
9. Forever Young	5:24	2:09	
10. Broken Arrow	2:07	0:46	
11. In the Midnight Hour	2:17	1:09	
12. *Instrumental with brass -*	2:41		
13. Get Back	3:04	1:38	
14. You're in My Heart	5:29	2:47	
Back-up singer closes with high notes	0:20		
15. The First Cut is the Deepest	7:39	2:47	
16. Highgate Shuffle	3:55	0:55	
17. Reason to Believe	2:23	1:38	
18. Da You Think I'm Sexy	6:24	1:39	
19. This Old Heart of Mine	4:08	2:47	
20 The Motown Song	4:02	2:40	
21. Encore Twisting the Night Away	5:36	2:32	
22. Rhythm of my heart	1:44	0:47	
Totals	1:36:22	44:53:00	**Percent Sang:** 46.58%

Observations of his performance included very physical routines using lots of mic stand twirling, lunges, arm movements and, of course, his signature move. He had high-energy dance breaks during the instrumental breaks. His voice was rough and started to worsen mid-concert. This was the first concert that he was noted to be using back-up singers (two females, two male). He had multiple costume changes across the show and took a break to drink something intermittently. He was seen playing with a small spotlight at one point when he had the audience sing the chorus of *Tonight's the Night* and was constantly moving. Chairs were brought out to sit during and instrumental/costume break before *Get Back.* A female backup singer took the closing high notes on *You're in my Heart.* His guitar player added a solo for *The First Cut is the Deepest.* He did manage to hit the high notes during *Reason to Believe* and had two more costume changes before the encore where he played with a soccer ball and had the audience sing the chorus of *Rhythm of my Heart.* There was minimal talking time when he wasn't singing.

This concert has been viewed by 2,661 people and no comments were available to analyze (**Table 6.39**).

Concert 4

The fourth concert was in 2008 and consisted of 18 songs over one hour and twenty-four minutes. The percent sang dropped minimally to 46% for this concert and this concert is after he had the vocal problems following thyroid surgery (**Table 6.42**).

Table 6.42: Singer 5 – Rod Stewart – concert 4

Rod Stewart **2008 Concert**			
Set List	Song Length	Total Time Singing ONLY	
1. It' A Heartache	2:33	1:42	
2. This Old Heart of Mine	3:48	2:30	
3. Forever Young	4:07	1:35	
4. Some Guys have all the luck	3:46	2:10	
5. Rhythm of My Heart	5:04	2:15	
6. Downtown Train	6:08	2:21	
7. The First Cut is the Deepest	4:43	2:18	
8. You're in My Heart	4:01	2:46	
9. Having a Party	3:35	1:30	
10. *Proud Mary - backup singers*	4:07	0	
11. Hot Legs	4:12	1:32	
12. Baby Jane	4:29	1:56	
13. Have I Told you lately	4:06	2:23	
14. Have you ever seen the rain	3:25	2:25	
15. Young Turks	4:37	2:00	
16. Maggie May	5:10	2:46	
17. Da You Think I'm Sexy	5:14	2:12	
18. Sailing	5:01	1:43	
Totals	1:18:06	36:04:00	**Percent Sang:** 46.18%

There was a notable energy change with this concert. Rod's movements were more toned down and controlled. The set was more impressive and he used a movie preview type introduction that announced Rod and his "gravelly voice". He used three female back-up singers and a female sax and violin player. He continued to use movie screen graphics and better lighting during the concert. His drummer was noted to be using a drum shield. The backup singers were riffing and singing the high notes at the end of *Rhythm of my Heart* and the audience sang along for part of *The First Cut is the Deepest.* His tradition of kicking soccer balls around continued during the *Hot Legs* instrumental and he forgot some lyrics of *Baby Jane.* He included more covers of other artists songs during this show. Rod left the stage and went outside to where fans were gathered during *Da You Think I'm Sexy* and did not sing this song in full voice. He also had the backup singers take the high notes on the last song, *Sailing.*

This concert was viewed by 1,258,857 people who left 171 comments (**Table 6.39**). Of these, one was positive regarding overall performance and age, *"Excellent!!! Hard to believe this man was 64/65 years old when this was recorded. AWESOME!!!"* (user SW) and two were negative. *"I love Rod, but the voice is shot"* (user RW) and *"haha, he got the lyrics wrong in baby jane."*

Concert 5

The fifth concert was in 2012 where Rod performed 19 songs over one hour and forty-six minutes. The percent sang for this late career concert decreased to 41% (**Table 6.43**).

Table 6.43: Singer 5 – Rod Stewart – concert 5

Rod Stewart 2012 Concert			
Set List	Song Length	Total Time Singing ONLY	
1. Love Train	3:26	1:50	
2. It's a Heartache	2:55	2:01	
3. Tonight's the Night	3:08	2:01	
4. Having a Party	3:15	1:03	
5. Some Guys have all the luck	3:54	2:06	
6. Rhythm of my heart	5:29	2:10	
7. Young Turks	4:37	1:52	
8. Forever Young	4:03	1:41	
9. Downtown Train	7:41	1:58	
Acoustic Set			
10. Reason to Believe	3:04	1:38	
11. Have I told you Lately	4:24	1:43	
12. The First Cut is the Deepest	4:33	1:52	
13. I Don't want to talk about it	4:24	1:31	
Sweet Little Rock n Roller	4:45	1:46	
14. *Proud Mary - backup singers*	4:15	0	
15. You're in my Heart	3:52	2:31	
16. Hot Legs	4:12	1:29	
17. Have you ever seen the rain	3:42	1:44	
18. Maggie May	5:32	2:28	
19. Da You Think I'm Sexy	5:50	2:20	
20. Love Train	1:27:01	35:44:00	
21. It's a Heartache	3:26	1:50	
Totals	2:55	2:01	**Percent Sang:** 41.06%

Performance and vocal observations included an overall roughness to his voice and lack of resonance coupled with difficulty hitting higher notes. His voice didn't carry well over the other sound, possibly due to the increased noise in his vocal signal. He spoke some of the lines that should have been sung over the backup singers ("you don't need those tickets, ride the train", etc.). He had to restart the second song, *It's a Heartache* because his voice sounded so rough. At this concert he has continued his trend of female musicians and backup singers with three of each. His speaking voice was slightly clearer after the second song. He had the audience sing along during the choruses of *Tonight's the Night, I Don't Want to Talk About It,* and *Have you ever seen the Rain.* It was hard to hear him over the backup singers and there was more pitch instability in his voice. He had the backup singers sing the high notes consistently across the concert. The entire band sang along on the final song, *Da You Think I'm Sexy.*

This concert was viewed by 310,327 users who left a total of 58 comments (two positive, nine negative) (**Table 6.39**). User MP wrote, *"Great show as always. Looks like Rod and the band are having as much fun as anyone in the building"* and OS commented, *"I have been going to see him since 1974 and have never seen a bad show!! The Man lives to entertain."* Others noted the change in his voice, *"Yes, I remember back in the day when he made a "comeback" of sorts, having ditched the eyeliner and leopard skin tights....his voice was in fine form that night....he sang "If loving you is wrong" and I remember a chill running down my spine when he hit the high notes.....all things must pass, I suppose....."* from user FH, and SU agreed, *"Thank you my friend, I was a big Rod fan years ago, alas, he sounds sad now because of all of the reasons that you've stated.*" He later added, *"It pains me to say what I'm saying, the man was one of the best vocalists ever."* Another user, SA wrote, *"It saddens me to hear rod sound so bad & sing those awful cover versions, back in the day he was original & possessed one of the best singing voices in music, especially live, I had to switch this off after the first two songs.* FH replied,

> *"Couldn't agree with you more....."I'd rather go blind" is one of my all-time favs....and is indeed the best version that I've heard also,*

> *including Etta....I just finished watching the "Tonight I'm yours" live concert from the 80's....and indeed, his pipes were in fine form that night....but time, thyroid cancer surgery, and straining the vocal cords all those years has finally taken its toll......I wouldn't even mind the new "voice" if it wasn't used to sing dreck like his latest....(shudder)"*

User SA replied, *"That's not the Rod Stewart you liked back in the 70's, I'm being honest, I've seen about 12 times over the years, I wouldn't watch him, unfortunately time has caught up on his voice."* Viewer SW wrote, *"Good response...I feel the same way...time for him to go quietly into rockstar retirement..."*

Concert 6

The sixth and final concert was in 2018 where Rod sang 22 songs over one hour and forty-six minutes. His percent sang for this late career concert remained at 41% (**Table 6.44**).

Table 6.44: Singer 5 – Rod Stewart – concert 6

Rod Stewart 2018 Concert			
Set List	Song Length	Total Time Singing ONLY	
1. Infatuation	3:04	0:45	
2. Having a Party	3:07	1:18	
3. Some Guys have all the luck	4:04	1:47	
4. Young Turks	6:00	2:21	
5. Tonight's the Night	3:21	1:45	
6. It Takes Two - with Cyndi Lauper	3:43	1:29	
7. Forever Young	4:58	0:57	
8. Forever young end	1:46	0:28	
Instrumental fiddler with Irish Dancers	1:27		
9. I'd Rather Go Blind	5:11	1:58	
10. Sweet Little Rock & Roller	4:07	1:32	
11 .Rhythm of my Heart	3:20	2:18	
12. Maggie May	5:10	2:45	
13. Downtown Train	3:38	2:00	
Stripped- Acoustic			
14. *Instrumental*	3:28		
15. You're in my Heart	3:44	2:51	
16. The first cut is the deepest	5:20	2:32	
17. Grace	5:30	3:29	
18. Have I told you lately	4:55	2:26	
Main set part 2			
19. *Nutbush City Limits*	3:57		
20. Stay with me	5:37	1:21	
21. Da You Think I'm Sexy	7:21	2:18	
22. Sailing	4:04	3:21	
Totals	1:36:52	39:41	**Percent Sang:** 40.97%

Observations of vocal and performance changes revealed multiple issues. Overall, he was vocally pitchy during this concert although his voice was clearer and stronger than the concert five. He talked some of the chorus lines while the backup singers sang them. Rod sang the wrong lyrics at the end of *Young Turks* and stopped the song and restarted. He was sweating quite a bit by the end of the fourth song; physical stamina appeared to be declining. He was off balance when he was doing kicks. He brought back his opening act, Cyndi Lauper, to sing several songs with him. Rod told his “girls” to “introduce themselves to save him from doing it”. He had a new Irish dance break in *Forever Young* and added a harp introduction on *The First Cut is the Deepest.* He sat down on the stage step to sing *Downtown Train.* He commented multiple times on the lack of energy from the audience telling them, *“You’re not like a Friday or Saturday night crowd – you must be full from a Sunday dinner.”* Overall, there was minimal dancing compared to his younger years.

This concert was viewed by 24,503 people who left 34 comments. Four were positive and ten were negative (**Table 6.39**). User SV wrote, *“That was a great concert! Rod is still an amazing performer and singer. Only complaint is that he didn't sing Hot Legs. But other than that, a magnificent show! Thanks for recording and posting the entire concert. Good job!!”* TT wrote, *“What kind of person gives this legend, who works harder than ANY performer, and does it at the age of 73 a thumbs down!?” User KD remarked, “Shit, to be that fit and in shape at 73!”* and user LA agreed, “*His voice sounds good!”* SF also acknowledged aging changes, *“THE LEGEND Rod, you don’t have to dance, you don’t have to move, Brother of the Universe, we just wanna hear you sing, and will always, as fellow human-beings, realize, that in aging, we all have our decline. You Sir, have been an exception to the rule. You, are a LEGEND.. Thank you for all the joy & Rock & Roll you made for the soundtrack of my life.”* Another viewer agreed, *“For a fact! He’s never been happier on stage. His shows are slicker now. But SO WHAT…he is recording some of his best work in the last 6 years, and filling arenas (with audiences ranging in age from 9 to 90) around the world, like no man ½ his age!”* There were also a number of unhappy fans. User NC wrote, *“I always loved his Music* *but have lost all respect for him after I saw live performance in Malta. he just treated his fans like shit, during the concert he kept checking on his watch and at one time he even disappeared for 20 minutes with the band playing without vocals, I had been waiting to see him live for ages and was totally disappointed."* SL added, *"Wow. He can't sing worth snot anymore. LMAO. Used to have the best voice of them all. Now he's a money grabbing ho that offers shit for service."* MS was also unpleased with the performance, *"Rod Stewart is an old grandmother onstage now, still entertaining in talk shows.....but he should stop his fidgeting onstage."* Another viewer remarked,

> *"Couldn't agree more. Saw him with the Faces 71, Greek Theater 95 and he was already losing it then. In fact in Forever young at the Greek, he got so screwed up in his throat the sound mixer mixed him down way below the band for the whole song. He looked so embarrassed and sheepish during that song. After it he went off stage for a bout ten minutes during he had the background singers do some old medley of soul hits. Then he returned and his voice stayed ok for the rest of it. Couldn't believe how bad it was when he lost it temporarily though. Would like to know what elixir backstage fixed him back up so well."*

User MF wrote, *"We had him on the German late evening talk show "Markus Lanz" recently and he's still a very amusing + entertaining conversation partner...but please NO more of such live singing shows. It's consequence of an aging voice + we all still revere him for his achievements in the past but he should better stop that now! I wonder who all wrote that ridiculous adulation stuff here, the sound is also pretty awful!"* One viewer remarked, *"Age kills throats.*

People love holding on to the shredded past too. Engaging conversationalist I agree. Just like McCartney. Tell him to quit too." Finally, TT wrote, *"Elton John said Rod could sing the phone book and it would be a hit."* And BJ replied, *"And Rod can still sing and Elton can't anymore!"*

Singer 6 – Bob Dylan

Bob Dylan is currently 78 years old and has performed a total of 3,735 shows over his 62-year career. He has recorded 38 studio albums and sold over 100 million records (**Table 6.4**). Six of his concerts (1976, 1985, 1990, 2000, 2009, and 2016) were analyzed for a total of seven hours and 48 minutes. These selected concerts ranged from nine to 21 songs with a total concert time between 43 minutes and one hour 42 minutes. At his early career point, his percent sang was 44.5%. Mid-career was 38.5% and late career was 33% (**Table 6.45**).

Table 6.43: Singer 6 – Bob Dylan results

	1st	2nd	3rd	4th	5th	6th
Total Concert Length	43:25	54:28	1:33:00	1:54:00	1:01:00	1:42:00
Number of Songs	9	10	18	18	10	21
Total Song Time	39:48	52:11	1:27:30	1:43:10	59:32	1:31:50
Total Time Singing	20:57	18:43	30:34	42:54	15:25	36:26
Percent Sang	53%	36%	35%	42%	26%	40%
	Early Career	44.5%	Mid Career	38.5%	Late Career	33%

This reflects a consistent decrease in the percent sang across his career.

Dylan's vocal genre is folk and he is a Nobel Prize winning singer/songwriter with a gritty vocal quality. In fact, fellow singer David Bowie wrote a song for him, *Song* *for Bob Dylan*, where he compares his vocal quality to "sand and glue". Aside from his drug and alcohol abuse, Dylan is a known smoker of both cigarettes and marijuana, which can contribute to vocal fold changes. His voice has changed across his career and although he is a notorious recluse offstage, he also has difficulty giving up the spotlight. This is addressed in his biography, *Dylan – The Biography.*

> *"And yet off stage, Dylan faded further and further from view. Some thought he'd retire and make periodic comebacks like Sinatra, lapsing a little more each year away from center stage. Critics who dismissed him or fans who simply forgot who he was mistook his increased anonymity for retreat. While they paid occasional homage as if he were an old quarter horse, Dylan refused to be put out to pasture. "There's a certain part of you that becomes addicted to a live audience," said Bob. "I wouldn't keep doing it if I was tired of it." (p. 461)*[270]

Concert 1

The first concert was in 1976 where Dylan sang nine songs across forty-three minutes. His percent sang was a career high of 54% (**Table 6.46**).

Table 6.46: Singer 6 – Bob Dylan – concert 1

Bob Dylan	**1976 Concert**		
Set List	Song Length	Total Time Singing ONLY	
1. Mr. Tambourine Man	3:27	3:27	
2. Isis	5:27	5:27	
3. When I Paint My Masterpiece	4:44	4:44	
4. Knocking on Heaven's Door	3:39	3:39	
5. Blowing in the Wind	3:37	3:37	
6. I Dreamed I Saw St. Augustine	2:27	2:27	
7. Like a Rolling Stone	6:45	6:45	
8. Just Like a Woman	5:20	5:20	
9. The Times They be a Changing	4:22	4:22	
Totals	39:48:00	39:48:00	**Percent Sang:** 52.64%

Observations from the concert noted increased singing from later concerts and a larger vocal range. He sang duets in unison with band members and carried more of the load when singing together. (note – this was an edited concert to eliminate clapping. No old fully uncut concerts were available for analysis).

This video was seen by 137,715 viewers who left 233 comments (**Table 6.47**).

Table 6.47: Singer 6 – Bob Dylan – concert comments

	Total Views	Total Comments	Voice -Positive	Voice - Negative
1976	137,715	233	2	1
1986	74,698	152	1	1
1990	44,660	42	0	1
2000	28,242	55	0	0
2009	22,913	29	0	0
2016	178,503	132	5	13

User GM wrote, *"Dylan at his peak. Unbelievably good"* and JC agreed, *"Dylan in my opinion at his best during the 70's when his voice was amazing."* Viewer RJ noted, *"The last great vocal period for Dylan before his vocal became only a twang... great rendition, quick, assured, & precise..."* and GD agreed, *"This tour ruined his voice for good. But damn it, it was worth it."*

Concert 2

The second concert was in 1986 and included ten songs over fifty-four minutes. His percent sang for this concert dropped significantly to 36% (**Table 6.48**).

Table 6.48: Singer 6 – Bob Dylan – concert 2

Bob Dylan	**1986 Concert**		
Set List	Song Length	Total Time Singing ONLY	
1. In the Garden	5:24	2:22	
2. Just Like a Woman	4:46	1:37	
3. Like a Rolling Stone	5:52	1:52	
4. It's All Right Ma	6:05	3:00	
5. Girl From the North Country	3:48	1:04	
6. Lenny Bruce	5:30	2:15	
7. When the Night Comes Falling From the Sky	4:45	1:56	
8. Ballad of a Thin Man	4:23	1:33	
9. I'll Remember You	4:04	1:17	
10. Knocking on Heaven's Door	7:34	1:47	
Totals	52:11:00	18:43	**Percent Sang:** 35.87%

Notable changes were apparent in his vocal style. Compared to the first concert, he was singing less and using more "talk-singing". There was an apparent lack of breath support noted with a truncated upper range and lack of sustained notes. He had increased nasality and decreased articulation which made him harder to understand. He used a harmonica at this point to carry the vocal line on songs (*Girl from North County* and

Knocking on Heaven's Door) and also played the guitar. Dylan used backup singers and bandmates to help with harmonies and/or carrying the melody. He was observed to be hoarse on the higher notes of *I'll Remember You*. Tom Petty played guitar for Dylan at this point and sang the lead on the last song (*Knocking on Heaven's Door).*

This concert was viewed by 74,698 people who left 152 comments (**Table 6.47**). User AS wrote, *Must be one of his best shows ever so much energy*" and W1 noted, *"This is the best live Dylan-Dylan sounds great and the band is amazing. No mumbling, weird rhythms."* One user, TD disagreed stating, *"Dylan can't sing".*

Concert 3

The third concert was in 1990 where Dylan sang 18 songs and performed for an hour and 33 minutes. At this concert, percent sang was 35% (**Table 6.49**).

Table 6.49: Singer 6 – Bob Dylan – concert 3

Bob Dylan 1990 Concert			
Set List	Song Length	Total Time Singing ONLY	
1. Subterranean Homesick Blues	3:35	1:27	
2. I'll Remember you	6:21	2:41	
3. Stuck Inside a Mobile with the Memphis Blues again	4:55	1:43	
4. Tears of Rage	3:35	0:59	
5. Masters of War	4:36	1:27	
6. Gotta' Serve Somebody	6:03	1:59	
7. Tomorrow is a Long Time	6:20	2:31	
8. Desolation Row	7:00	2:35	
9. The Lonesome Death of Hattie Carroll	4:49	2:13	
10. John Brown, One Too Many Mornings	4:15	1:12	
11. Everything is Broken	3:37	1:07	
12. Simple Twist of Fate	5:10	1:45	
13. All Along the Watchtower	3:48	0:42	
14. I Shall Be Released	4:12	1:18	
15.. Like. A Rolling Stone	5:54	2:02	
16. Barbara Allen	3:11	1:41	
17. The times they are a Changin'	5:00	1:34	
18. Highway 61 revisited	3:43	1:19	
19. Encore	1:26	0:19	
Totals	1:27:30	30:34	**Percent Sang:** 34.93%

Throughout this concert, Dylan was unintelligible at times. He used the harmonica more on *Tears of Rage*, *Tomorrow is a Long Time*, *The Lonesome Death of Hattie Carroll*, and *Everything is Broken*. He continues his typical pattern of minimal talking during the show with no introduction of the next song. His voice was stronger and better in quality than the last concert.

This show was viewed by 44,660 users who left 42 comments (**Table 6.47**). There was one related comment by user RL, *"Brilliant lyrics, indifferent singing, garage rock blare."*

Concert 4

The fourth concert was in 2000 and consisted of 18 songs over one hour and 43 minutes. The percent sang for this concert was slightly increased at 42% (**Table 6.50**).

Table 6.50: Singer 6 – Bob Dylan – concert 4

Bob Dylan 2000 Concert			
Set List	Song Length	Total Time Singing ONLY	
1. Hallelujah, I'm Ready to Go	2:05	1:06	
2. Got to Serve Somebody	6:39	1:36	
3. Desolation Row	8:12	2:36	
4. Ballad of Frankie Lee and Judas Priest	5:18	3:37	
5. Tangled up in Blue	7:40	2:47	
6. Searching for a Soldier's Grave	2:52	1:29	
7. Country Pie	2:47	1:02	
8. Blind Willie McTell	5:38	2:53	
9. Tombstone Blues	5:53	2:30	
10. Tryin' to Get to Heaven	4:52	2:39	
11. Cold Irons Bound	5:27	2:36	
12. Leopard-Skin Pill-Box Hat	5:33	2:06	
13. Things Have Changed	5:41	3:30	
14. Like a Rolling Stone	6:24	3:44	
15. Don't Think Twice, it's Alright	7:03	2:10	
16. Watching the River Flow	5:18	1:58	
17. Forever Young	5:55	1:34	
18. Highway 61 Revisited	5:00	1:11	
19. Blowin' in the Wind	4:53	1:50	
Totals	1:43:10	42:54:00	**Percent Sang:** 41.58%

It was noted that he used backup singers more consistently during this performance. Dylan was hoarse by the second song of this concert. He had better articulation although pitch was inconsistent and he used a speech-singing style. He sang in unison for a duet on *Gotta Serve Somebody* and didn't move around much onstage during this show. He again used minimal talking across the performance and introduced the band after the 10th song. He used the harmonica less, only on *I Shall Be Released.* Most apparent, he changed the melody on *Blowing in the Wind*.

This concert was viewed online by 28,242 people who left 55 comments (**Table 6.47**). User MK wrote, *"I saw him twice during this period, in Denver then Boulder, and when he spoke it was like a king was speaking. Both were divine shows."* There were no other relevant comments.

Concert 5

The fifth concert was in 2009. Dylan sang ten songs over 61 minutes. During this late-career concert he hit a career low percent sang of 26% (**Table 6.51**).

Table 6.51: Singer 6 – Bob Dylan – concert 5

Bob Dylan 2009 Concert			
Set List	Song Length	Total Time Singing ONLY	
1. Watching the River Flow	4:30	1:12	
2. Stuck Inside of Mobile with the Memphis Blues Again	6:28	1:54	
3. Don't Think Twice, it's Alright	6:00	1:13	
4. Highway 61 Revisited	5:30	1:01	
5. The Leaves are Goanna Brea	7:28	2:28	
6. Blowin' in the Wind	4:42	1:06	
7. This Wheels on Fire	5:45	1:07	
8. Things have Changed	6:12	1:46	
9. Desolation Row	9:24	2:31	
10. Gotta' Serve Somebody	3:33	1:07	
Totals	59:32:00	15:25	**Percent Sang:** 25.90%

He increased harmonic use on *Stuck Inside of Mobile with the Memphis Blues Again*, *Blowing in the Wind*, and *Desolation Row*. He used a staccato-like disconnected singing pattern on *Things Have Changed*. Dylan overall was noted to use even less breath support with little to no vocal phrasing as he sang.

This concert was viewed by 22,913 users who left 29 comments (**Table 6.47**). No comments were relevant for this study.

Concert 6

The sixth and final concert was in 2016 and Dylan sang 21 songs over one hour and 42 minutes. His percent sang almost doubled for this concert to 40% (**Table 6.52**).

Table 6.52: Singer 6 – Bob Dylan – concert 6

Bob Dylan	**2016 Concert**		
Set List	Song Length	Total Time Singing ONLY	
1. Things Have Changed	5:00	2:45	
2. She Belongs to Me	4:05	1:12	
3. Beyond Here Lies Nothing	4:08	0:53	
4. What'll I Do	2:45	1:30	
5. Duquesne Whistle	6:21	2:02	
6. Melancholy Mood	3:00	1:00	
7. Pay In Blood	4:20	1:54	
8. I'm A Fool to Want You	4:45	1:58	
9. That Old Black Magic	2:56	1:41	
10. Tangled Up in Blue	5:32	2:18	
11. High Water	4:34	2:23	
12. Why Try to Change me Now	3:09	1:47	
13. Early Roman Kings	5:50	2:18	
14. The Night We Called it a Day	3:40	1:19	
15. Spirit on the Water	6:05	2:12	
16. Scarlet Town	5:36	2:20	
17. All or Nothing	2:45	1:12	
18. Long and Wasted	3:52	1:28	
19. Autumn Leaves	2:54	1:11	
Encore			
20. Blowing in the Wind	5:20	1:26	
21. Love Sick	5:13	1:37	
Totals	1:31:50	36:26:00	**Percent Sang:** 39.67%

During this performance, Dylan used the harmonica on *She Belongs to Me* and *That Old Black Magic* and incorporated the harp on *Blowing in the Wind*. He was noted to have a slightly better use of his overall range for this concert and improved articulation on only the songs he covered – not his own songs. His voice was relatively consistent across the concert although he was noted to be hoarse and raspy when using his upper range.

This concert had 178,503 viewer who left 132 comments (**Table 6.47**). User DM wrote, "*He really is better than ever!"* and MV remarked, *"why would you want him to sound any different than he naturally does? he's 75 ffs! ... if you look back he's never sounded the same twice ... this is just another different sound ... he sounds great his phrasing is awesome the band is amazing :)"* Another user, CB, agreed, *"I can't believe how great he sounds. WOW. bobby!!"* and GJ wrote, *"I love it! he is better than ever." "Totally agree. Bob is just like a good wine, getting better as he gets older."* However, many fans were not as pleased. BJ wrote, "*This audience can't understand, for the most part, a word this man is singing."* and NP agreed, *"I'm pretty sure the crowd can't understand what Bob is singing and that's OK, neither can I."* This was a similar theme with PM writing, "*Great band! But I don't understand a word he is saying. Now that's class!"* Several users disagreed with comments of how good he sounded, *"no way. he is still extremely unique and spectacular, but young Dylan's voice is unmatched."* and *"No. Wrong. This is Bob; but this is painful. The band is good. The songs are good: but time has passed."* User TD wrote, *"I'll say this, this man has guts."* And ST agreed *"His voice is so far gone he should have retired years ago….. he is THE GREATEST*

SONGWRITER/PERFORMER IN THE HISTORY OF ROCK. HANDS DOWN. NO ONE EVEN CLOSE." Viewer RH noted, *"Nice band and tunes. Great songwriter - never a good singer. So he's 75. I can't hear the words he's almost singing. Time to give it up Bob and rest on your laurels. :)"* and KP wrote, *"Massive Dylan fan since 1975 when I was 12. I'm glad I can see his current show on youtube without buying tickets and going, because I'd be pissed. What a snorefest.. he's awful now."* User NJ agreed saying, *"I wouldn't pay one red cent to listen to this over rated drugged out old dead beat".* This was also noted by MS, *"lovely music. He should have won the Nobel prize in the 60s or 70s, not now; his voice fucked him. I guess he still pleases his oldies fans."* User SK was also disparaging, *"Bob Dylan's current voice. For me, very unpleasant. After seeing this video, I would never attend one of his concerts. Obviously, no reflection on his past accomplishments."* Finally, CB wrote, *"I've loved Bob's music most of my life, since Blood On The Tracks but this is crap. It really is time he gave it up and stop resting on what he was."*

Statistical Analysis

Singing percent at the different career stages is summarized as mean ± SD. For the outcome of singing percent, the early career measures are compared to the mid-career measures, and the mid-career measures are compared to the later career measures, by running paired t-test. A repeated measures ANOVA was conducted on the early, mid, and late careers to evaluate whether the singing percent goes down as singers age. The same data of the early, mid, and late careers were also evaluated using a repeated measures mixed model that treats the time intervals of the careers to be unequal.

To further investigate the trend of singing percent over the time, a mixed model repeated measures analysis looking at the six time points of measurement data is implemented, treating the first measurement as baseline and using it as a covariate in the model. All the tests are two-sided. The statistical analyses were performed with the SAS software (version 9.4; SAS Institute, Cary, NC).

Results

The singing percent is summarized as 48.83 ± 11.69 for the early career, as 52.50 ± 16.22 for the mid-career, and as 48.25 ± 15.33 for the late career. The paired t-test showed that there is no significant change in singing percent from early careers to mid careers (mean change = 3.67, 95% confidence interval (-4.33, 11.66), p-value = 0.29). The paired t-test showed that there is no significant change in singing percent from mid careers to late careers (mean change = -4.25, 95% confidence interval (-15.71, 7.21), p-value = 0.38).

The repeated measures ANOVA on the early, mid, and late careers, which applies an unstructured covariance structure, showed that there is no significant change in singing percent over the time from early careers to late careers. The p-value is 0.59. The repeated measures mixed model on the early, mid, and late careers, which uses a spatial power covariance structure for unequally spaced intervals, showed that there is no significant change in singing percent over the time from early careers to late careers. The p-value is 0.47.

The repeated measures mixed model on the six times of measurement data, which uses a spatial power covariance structure for unequally spaced repeated measures, showed that time has no significant effect on singing percent (p-value = 0.74).

The audience comments were analyzed using thematic coding that was ideographic in approach. After all comments discussing age-related vocal and/or performance observations were collected, a total of 141 comments were highlighted as meaningful statements from the audience comments. Each comment was further examined and grouped together into 15 categories of shared formulated meaning. From these 15 categories, four themes emerged that reflected the collective experience of the audiences in relation to the six singers. The four themes are presented in the fan finding summary section.

The data collected on **Table 6.2** – Data Sheet for Compensatory Behaviors, was also analyzed using thematic coding. Episodes of performance and vocal accommodations were examined and grouped together with behaviors of a similar purposes coded together into a more general category. From these main categories, three themes emerged that reflected the overall motive behind the singer's vocal and performance accommodations. The three themes are presented in the vocal and performance accommodation summary.

Discussion

Aging elite vocal athletes have no intention to go quietly into the night to "Rockstar Retirement". They have this unquenchable thirst for the spotlight and an unfillable need to have the audience's approval. Rod Stewart, among others, acknowledge this concept in his autobiography.

> *"I worry about the end of my career far more than I worry about aging…What I'm hoping is that I'm going to have the judgment and the foresight to pack it in at the right time instead of hanging around for ages, playing smaller and smaller places….* ***But, at the same time, who knows how desperate one could be to keep it going, in some form— or any form?*** *After all, the performing— it's who I am. It feels like what I was put down here to do."*[212]

Through this study, even though no significant changes were found, we gained insight into the vocal and performance changes of aging elite vocal athletes across their lifespan. Our six singers ranged from age 70 to 93 and not a single one of them has any intention of quitting. Not even Elton John, who has made the latter part of his career an endless stream of retirement threats and "final" concerts. He is once again on a retirement tour – one that is currently booked to last three years and adding additional dates on a weekly basis.

Our findings reveal multiple age-related voice and performance changes to the six singers along with the accommodations they are making for these changes. While there were no significant results, there is a tendency to decline with percent sang. The accommodations are presented within the broad categories of vocal and performance adjustments: additions, deletions, and distractions. The effectiveness of these accommodations intermingled with the fans' reactions to them were categorized into the four main types of fans: those who want change, those who accept the change, those who hate the change, and those who don't care and simply love their Rock Star. Finally, recommendations for intervention to help reverse or accommodate to these changes are presented.

Percent Sang Summary

We saw a tendency to decline in percent sang for four of the six singers (Tony Bennett, Billy Joel, Rod Stewart, and Bob Dylan) by their late career point and an increase for Elton John and Steven Tyler (**Table 6.53** and **6.54**), however no overall trends were identified. This finding is not surprising as these singers are uniquely different and have built a career around what works for them.

Table 6.53: Percent sang across career

	1st	**2nd**	**3rd**	**4th**	**5th**	**6th**
Tony Bennett	53%	65%	71%	72%	54%	42%
Billy Joel	54%	46%	55%	52%	49%	51%
Steven Tyler	43%	33%	36%	31%	41%	40%
Elton John	61%	70%	69%	74%	83%	71%
Rod Stewart	29%	43%	47%	46%	41%	41%
Bob Dylan	53%	36%	35%	42%	26%	40%

Table 6.54: Percent sang by early, mid, late career averages

	Early Career	Mid - Career	Late Career
Tony Bennett	59%	71.5%	48%
Billy Joel	50%	53.5%	50%
Steven Tyler	38%	33.5%	**40.5%**
Elton John	65.5%	71.5%	**77%**
Rod Stewart	36%	46.5%	41%
Bob Dylan	44.5%	38.5%	33%

To this end, in his seventh decade of life, Elton John continues to sing an impressive 71% per concert, an increase from his younger years. Steven Tyler, Rod, Stewart and Bob Dylan all maintain around 40% at this same time point. These data are not generalizable to other singers for many reasons, the first of which being the limited time points we observed. Multiple reasons aside from aging can contribute to a decrease percent sang per concert, however there does appear to be an overall tendency to decreased time singing that is likely correlated with increased age. Tony Bennett, who is roughly 20 years older than the other five singers, highlights this tendency to decline during the twilight years of his career.

Vocal and Performance Accommodation Summary

The analysis of our six singers at various points across their long careers revealed three overall types of accommodations for vocal changes. As these accommodations were observed across a 40 to 50-year timeframe, we can’t say that they were exclusively due to aging, however there was a noticeable increase in the amount and type of accommodations for some of the artists during their late career points.

The fan finding analysis resulted in three themes of performance and vocal accommodations: additions, deletions, and distractions. Additions were defined as the addition of something to their vocal or performance output such as having the back-up singers sing the high notes or using longer instrumental breaks. Deletions were defined as the deletions of something from their vocal or performance output such as cutting out the high notes completely or using less movements or personal choreography. Finally, masking was defined as strategies that served the goal of masking the vocal and/or performance weakness. An example of this would be the use of digital enhancement through backing tracks or adding show elements such as Irish dance to distract the audience from noticing the song wasn't the same as the studio album version. Of the six performers, all but Elton John used additions and distractions for vocal accommodations. Billy Joel, Elton John, and Rod Stewart also had deletions. For performance accommodations, Tony Bennett, Billy Joel, Steven Tyler, and Rod Stewart all used additions and distraction for performance accommodations. Billy Joel, Elton John, Rod Stewart, and Bob Dylan also used deletions. These data are reflected below (**Table 6.55 and 6.56**).

Table 6.55: Vocal accommodations by singer

	Additions	Deletions	Distractions
Tony Bennett	X		X
Billy Joel	X	X	X
Steven Tyler (w/Aerosmith)	X		X
Elton John		X	
Rod Stewart	X	X	X
Bob Dylan	X		X

Table 6.56: Performance accommodations by singer

	Additions	Deletions	Distractions
Tony Bennett	X		X
Billy Joel	X	X	X
Steven Tyler (w/Aerosmith)	X		X
Elton John		X	
Rod Stewart	X	X	X
Bob Dylan		X	

Fan Findings Themes

Many users left comments that were uplifting, positive, and supportive of their beloved singers. Others were cruel and downright condescending in their remarks about their idols fall from the fountain of youth and some were in the middle. From the comment analysis, we categorized the audience response into four overall types of fans:

1. Those who want change – they want new arrangements of the old songs
2. Those who accept the change – they want the same melody/arrangement, but are ok with their idol's voice sounding different
3. Those who hate the change – the want the studio album experience at each concert, regardless of the elapsed time from the initial recording
4. Those who don't care, they just love the singer.

These four fan profiles certainly cannot encompass every fan, but serve as an overall archetype of audience members who left comments among the 36 videos. One important piece of judging whether an accommodation is successful or not is if it meets the overall expectations and desires of the singers' audience. This insight is important to keep in mind as we recommend accommodations for the singers.

Implications

This study examined the six singer's voices and performance strategies as they performed concerts across their lifespans. While percent sang did not reveal any statistically significant results, it was clear that the singers that were analyzed were very different and there appears to be a wide range of what the audience will happily accept from the singers in terms of concert time actually spent singing. This is an interesting finding and is promising in terms of making performance and vocal accommodation recommendations designed to keep the singers singing that may reduce their overall vocal load. The themes that emerged from the fan comments suggest that the accommodation recommendations need to not only work for the singer, but also meet the expectations of the audience.

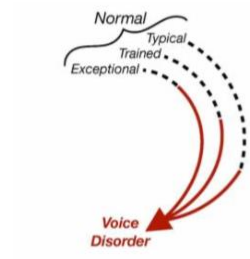
There were multiple examples of accommodations to vocal and performance changes of the singers across the concerts. The most successful ones were the accommodations where the audience didn't even realize what was happening. A representative of this would be Elton John's performance accommodations. His younger years were filled with high levels of physical activity – standing and dancing while playing the piano. As he aged, the physicality of the shows changed as he chose to go the route of deletions. Elton now primarily sits at the piano throughout his concerts, he dropped some of his high notes by an octave, and, according to fan feedback, is sounding better than ever. His fans are overall positive about the recent concert experiences, reporting how much they enjoyed the concerts, even though they seem to be aware that they are not seeing the same Elton John of his youth. Another example of successful accommodations was seen by Rod Stewart. He has made a career out of his rough vocal quality; however, his upper range appears to became more limited with age. He has adapted by using all three types of accommodations to craft a concert/stage show that is interesting to watch, involves more than Rod sitting and singing, and has high energy. As Rod Stewart grew older, he kept adding more and more young women to his show – musicians, singers, and dancers. They covered the high notes for him and performed solo vocal and dance pieces to give him a vocal break. He reduced his physical movements – his “signature move” was not seen in his late career concerts and he was overall more physically restrained. He increased his use of soccer balls during his shows to include a several minute period where he just kicked them into the audience. Rod also brought back his opening act, Cyndi Lauper, for several duets that also allowed him to keep singing, while reducing his overall vocal load. All together, these accommodations worked well to maintain audience enthusiasm and participation across the concert. While the commenters were aware of his vocal changes and commented regarding this, many still enjoyed the concert and thought it was a good show and he continues to mostly fill his performing venues.

These examples are meant to be models of some of the many options that singers can use to successfully accommodate to age related vocal and performance changes. While this specific research study focused on older singers these accommodations (additions, deletions, and distractions) can be used with singers of any age to accommodate to vocal problems, either acute or chronic to provide them with a “toolkit” of accommodation techniques to use when they need.

"The Exceptional Voice Protocol": Recommendations for the Aging Elite Vocal Athlete

Findings from the four components of this dissertation provide insight into the vocal and performance demands of aging elite vocal athletes, their experiences, and their current methods of accommodating to changes that allow us to propose and design a model of care that maximizes vocal output, performance, and singer well-being during the twilight of their career as they continue to perform and share songs that inspire and enrich the lives of the audiences. The goal of this model of care, or the "*Exceptional Voice Protocol*" (**Table 6.57**) is to help voice treatment and training specialists to further understand this unique population and to begin developing customized management plans for maintaining vocal and performance health across their careers

Table 6.57 - The Exceptional Voice Protocol



The Exceptional Voice Protocol

Name: ______________________ **Date:** ______________

Areas of concern: ____

____

____

Respiratory Efficiency: Increase Maintain

MPT: ____________ VC: ____________ PTP: ____________

Recommendations: ____

____

Phonation – Glottic Closure: Increase Maintain

Closure pattern: __________ Hyper/Hypofunction MW: Increased/Decreased

Recommendations: ____

____

Resonance – Voice Placement: Increase Maintain

Forward/Back Resonance shift: Y/N Other: ______________________

Recommendations: ____

____

Current Hydration: ____

Vocal Hygiene Areas of Need: ______________________________________

Vocal Exercise Plan:

1. *Respiration:* ____

   ____

2. *Phonation:* ____

   ____

3. *Resonance:* ____

   ____

Performance Areas of Concern: ______________________________________

____

____

Performance Recommendations:

1. *Additions:* ____

   ____

2. *Deletions:* ____

   ____

3. *Distractions:* ____

   ____

This protocol involves two integrated components within the overall treatment focus - vocal intervention and performance adjustment. The protocol is designed to first identify specific areas of weakness in the vocal and performance of the singer with the clinician then providing customized recommendations based on the singer's current abilities, performance schedule/demands, the expectations of the audience, along with any other identified variables that influence the concert. An example of the protocol customized to an elite vocal athlete will be presented in the following chapter.

Limitations and Delimitations

A potential delimitation of this study is that it solely examined the aging changes in male singers. This decision was based on hormonal variations between the male and female larynx, specifically during and after menopause, which could cause additional vocal problems. Future research should include repeating the study while looking at female elite vocal athletes across their singing/performing careers.

A limitation of this study is the lack of accessible full-length performances from the start of the singer's careers. This is due to the lack of accessibility of recording at that time. However, old material recorded on VHS continues to be digitized and made commercially available all the time. There is the potential in the future that there may be additional material representative of these singer's early years to analyze. Finally, the data analysis was conducted by two researchers, one licensed and certified speech-language pathologist who specialized in voice disorders and a research assistant. Both researches have a background in performing and singing. Although 20% of the concerts were also assessed by an outside reviewer, each researcher had their own biases and unique observations of the singers and their perceived vocal and performance accommodations. Further, the primary researcher had previous knowledge and experience working with aging singers that may have biased interactions. It is unknown if the research outcome would have been different if conducted by a sole researcher or a researcher with no experience with aging singers and the type of voice issues they may encounter. Finally, not all concerts had comments left by audience members. As the concerts were selected to meet specific criteria for full length unedited footage approximately 5-10 years apart, finding concerts that met that criteria and had comments regarding voice was not an option. Future research should further investigate audience reactions to see if the initial themes are consistent.

Conclusion

Recommendations for performance and vocal accommodations should be specific to the performer, their vocal and performance style, and their needs and will likely change across their career as age. The final chapter will present a brief summary of each of the components of this dissertation and integrate the results and the *Exceptional Voice Protocol* into a final discussion with an example of the comprehensive protocol for the habilitative and rehabilitation care of the aging elite vocal athlete

CHAPTER 7: DISCUSSION

Overview

Contemporary commercial music singers often find themselves experiencing potentially traumatic and career influencing vocal and performance related changes as they age.[1] These vocal changes are experienced by many people as they age, as reflected by study component III, however they are often felt earlier and subsequently have the potential to significantly impact the lives of these singers more quickly than for the normal voice. Without question, these elite vocal athletes have higher vocal demands than the typical aging avocational or trained singer and also have exceptional voices.[208,271,272] Because of this, treatment concerns for these elite vocal athletes are and should be very different than for the non-singer or trained singer. Although there is extensive research on younger singers,[181,273-280] there is currently limited research on vocal and performance related changes due to aging in the CCM population. There are multiple ways to examine this issue and for this dissertation, we have narrowed them down to two different, yet complementary paths - the clinical and lived experiences - that we look at from different perspectives. The viewpoint paper and three research studies that form the four components of this dissertation provided deeper insight into this question and are summarized below:

I. *In Support of the Exceptional Voice*[272]

In this viewpoint article, we suggest that the current definition of a voice disorder does not provide an adequate description of voice problems of elite vocal athletes. The current definition of a voice disorder (Figure 7.1) is a change in quality, pitch, and loudness of the voice that draws attention to the speaker.

Figure 7.1- Current Voice Production Continuum

Consequently, under the current definition of a voice disorder, these vocal changes may not qualify for vocal rehabilitation (and possibly health insurance coverage). Additionally, the clinical system of evaluation and intervention fails to meet the needs of the exceptional voice when even a subtle decline in vocal quality may affect performance. To address this issue, we offered a definition of the exceptional voice:

> "The exceptional voice is one that is highly trained to the demands of a particular field and that possesses unique vocal characteristics and abilities that differentiate that voice from those of the general population."

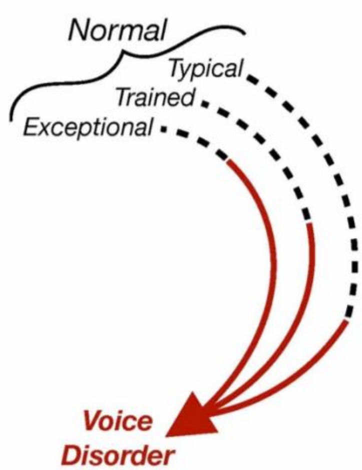


Figure 7.2 – The New Voice Production Continuum. The black dashed arcs represent the range of tolerance acceptable for a given voice user before that individual considers their voice as causing a problem. The red solid arcs represent the range of disorder severity by each class of voice user.

With the first part of the study, we have defined the problem – the difficulties that elite vocal athletes have accessing supported medical care throughout their career and as they age. We have proposed a modified definition of the exceptional voice and have proposed a new vocal continuum to support the argument that insurance should cover this population and provided recommendations regarding the habilitation and rehabilitation of the exceptional voice.

II. Against the Wind: A Qualitative Study of Singers Growing Old [1]

The second study employed a content analysis of 73 autobiographies and biographies and explored the perceptions of singers as they experience and accommodate to age-related voice changes. This study identified four overarching themes in singers' appraisal of these changes:

- Modest self-perception of their vocal prowess and its relationship to performance
- Acute sensitivity to changes in vocal quality

- Recognition of the critical association of vocal quality with their identity as a performer
- An array of accommodations to age related changes

These voice and performance transitions are framed from a life course perspective against the backdrop of the demands of a changing music industry, limited access to and use of clinic intervention, high and sometimes unrealistic audience expectations, and differing levels of responsibility of each of these constituencies. We realized that there is a need to provide empathy for the changes experienced by the aging singers and proposed supportive intervention that maximizes vocal performance and singer well-being that is especially needed during the twilight of their career as they continue to share songs that inspire and enrich the lives of audiences.

III. Vocal Function Exercises as a Treatment Modality for Presbyphonia – A Randomized Control Trial

The current study, component III of this dissertation, was a randomized controlled design while comparing pre-and post-treatment and one month follow up measures involving all five domains of voice assessment. This study examined the efficacy of VFEs in comparison to a structured speech production exercise protocol for enhancing voice production in individuals with presbylaryngeus. Results from this study demonstrated an unexpected increase in VHI scores for both groups following intervention that show that people must actually think they have a voice problem before the VHI is a useful clinical tool. Results from acoustics, aerodynamics, and auditory-perceptual domains were not statistically significant. However, in the visual-perceptual domain, exams of both high-speed imaging and videostroboscopy found no improvement in the ASP (control) group following intervention while there were significant findings in the VFE (exercise) group. These results confirm previous study results that VFEs are a successful treatment modality for presbylaryngeus. [109,119,172,174,182,185,187,194] This physiologic voice therapy technique is ideal to use with aging elite vocal athletes with a targeted focus on improved vocal stamina and flexibility.

IV. *Growing Old as a Rock Star – How DO they do it?*

This final study, component IV, used a naturalistic observation design that identifies age-related vocal and performance changes to examine how singers are accommodating to the changes and explore when the changes are working and when they are not as judged by fan reactions. We analyzed the performances of six elite vocal athletes and CCM male singers - Billy Joel, Elton John, Rod Stewart, Tony Bennett, Bob Dylan, and Steven Tyler – by assessing various live recordings of entire performances at various points in their lifespan that are readily accessible on the internet (YouTube).

Percent sang was calculated for each concert and averaged for early, mid, and late career points. Statistical analysis of these comparisons was not significant. There was an overall tendency to decreased percent sang in the later career concerts for four of the six singers. The types of vocal and performance accommodations observed by the singers included additions, deletions, and distractions.

Audiences' perception of the singer's performances was included by analyzing comments left regarding the performances on the videos. An overall profile of the fan responses included four reactions: those who want change, those who accept the change, those who hate the change, and those who don't care, they just love the singer.

The final piece of this study introduced a protocol, the *Exceptional Voice Protocol*, a customized intervention plan for choosing performance and vocal accommodations for the CCM elite vocal athlete. The customized intervention protocol is dependent on multiple factors - some age related and some related to the rock star lifestyle - and may change depending on the singer's needs and specialized recommendations regarding vocal and performance accommodations that are customized and targeted to these specific issues is critical to the successful application of this protocol.

Discussion

Elite vocal athletes are challenged as they age in sustaining their careers, yet the deterioration of the voice can significantly threaten or even end a career. Related changes do not occur independent of context. They occur in an environment of substantial changes in the music industry. The music industry has shifted significantly during the careers of these performers and the effect is widespread. Each of the singers had to reinvent themselves as the music industry and their primary income sources shifted with this realignment. In the past, singers were able to record an album, do a small tour for publicity, and sit back and let the money roll in as people purchased their albums. When the music industry shifted to a digital music platform, singers were no longer able to continue this model as they made minimal money from the digital platform and had to explore other income sources. The changing music industry has forced aging CCM singers/performers to return to active concert schedules to maintain primary income potential. They have adjusted reflect this. Several comments were left for both Bob Dylan and Elton John regarding ticket price increases across their careers. Fans remember $7 tickets for early concerts and were astounded by the $450+ price to get a similar seat at a recent concert. This price increase directly reflects the shift in the music industry from the sale of records as a primary income source to ticket sales and the purchase of merchandise at concerts as the primary source. Rock and roll royalty may be making up to several million dollars per concert but receiving minimal payment for their new albums. The current model has also required extremely lengthy tours with incredible numbers of shows per week, month, and sometimes over several years. This forces the artists to tour more and with less time off for vocal and physical recovery which increases their risk of experiencing a voice problem.

Another realignment brewing in the industry is the increase in musicians/bands turning to biopics, or autobiographical films, as an income source as they realize that extremely lengthy touring comes with a high cost. It is unlikely that the extensive tours will stop anytime soon and singers, particularly aging elite vocal athletes, continue to try to meet the current industry standards and fan expectations all the while trying to take care of their overall health and voice. Singers are acutely aware of the worst possible situation - cancelling a show. Rod Stewart spoke about this, *"Other nights, I had nothing there to sing with at all and shows had to be wiped out completely. And that I hated most* *of all. There's no such thing as a good cancellation. But the worst cancellation is one where the audience is already in the house. That just feels like an unpardonable waste of people's time."*[212] Aside from letting down the audience, another fear of canceling shows is losing insurability. He continues to say, "*It got to the point at the beginning of the 1990s where I was virtually uninsurable. Lloyd's of London had paid out so many times on shows that didn't happen that they simply weren't going to take the risk anymore. And if they didn't insure me, the cost of canceling a show was going to come right out of my pocket: the trucks, the crew, the buses, the flights. A stadium rock 'n' roll show is not an inexpensive venture."*[212] Other singers also spoke of the inability to obtain tour/concert insurance and the financial strain that it caused coupled with the looming threat of losing everything if they were uninsured and had to absorb the cost of cancelled shows. This drive to avoid cancelling "if at all possible" is strong and often involves people on the management team making the final decision on if the singer is to perform or not when it concerns voice issues instead of the artist with the support/recommendations of their medical team. This pattern can easily end in vocal suicide for the artist simply because the stakes are so high between the increased risk of vocal problems inherent with the occupation and the external and internal demands to perform at any cost.

The four components of this dissertation aimed to explore the awareness, struggles, and compensations of aging singers as they deal with age-related vocal and performance problems along with examining the efficacy of VFEs as a treatment modality for presbylaryngeus. It is apparent that performers are constantly having to reinvent themselves across their careers for multiple reasons. Age is one reason, but it also may be a result of changing stylistic demands as music, presentation, and the culture of how we listen to music continues to change. Trends change (i.e., the integration of videos during the concerts, more instrumental interludes) and the singers adapt. They are constantly striving to meet the expectations of their fans on multiple levels. As they become more successful and their fan base expands, their stage show quality usually improves to reflect the increased concert budget. There are many factors that they can control, such as the choice of using back-up singers, their band, the use of digital enhancement and/or visuals during the concert. There are also many variables that are out of their hands such as venue (location, outside vs. inside) and environmental factors (allergens, climate changes, dust in performing space). The singers can only try to mitigate any potential negative effects from these variables. One variable that they can't control is how their body, and subsequently their voice, ages.

Addressing Problems of the Aging Elite Vocal Athlete

The following section provides a brief overview of the type of potential problems the aging elite vocal athletes could be experiencing and how these problems affect both vocal and performance techniques across the three subsystems of voice production. In the following section we will address the three subsystems of voice production as an example of addressing the vocal component of the *Exceptional Voice Protocol*.

1. Respiration – Increase/Maintain Respiratory Efficiency

Decreased laryngeal resistance and reduced airflow is a typical manifestation of age-related dysphonia and can result in shortened phonation time which becomes increasingly noticeable when performing. Couple this with glottal insufficiency secondary to presbylaryngeus and the combination results in decreased maximum phonation times, increased air escape during voicing, and negative effects on speech production and vocal quality including increased breathiness, strain, and acoustic changes. Adults with both laryngeal and respiratory symptoms of aging have significantly more vocal symptoms when compared with adults who just have respiratory or laryngeal symptoms.[281] Therefore, it is important that we target improved respiratory efficiency throughout the vocal rehabilitation process.

Recommendation: We can initially target this goal with abdominal focused breathing exercises and continue to address it in a multi-system approach with Vocal Function Exercises, Semi-Occluded Vocal Tract Exercises, and Resonant voice exercises as the protocol progresses.

2. Phonation – Increase/Maintain Glottic Closure

Although numerous changes contribute to the physiological changes to the voice, one of the largest contributors is deterioration of the thyroarytenoid; the primary muscle of voice production.[18,73,282] Vocal fold atrophy, or bowing, is cited as the greatest cause of hoarseness in the elderly, where it was also found that subjects with this age-related atrophy also presented with higher jitter rates.[283] These changes can contribute to a lack of vocal fold closure and abnormal vibratory parameters which will lead to vocal issues such as decreased upper range and overall weakness, decreased stamina, and increased breathiness.

Recommendation: Presbylaryngeus can be treated using semi-occluded vocal tract exercises to initially establish coordination between respiration, phonation, and resonance. Vocal Function Exercises will then primarily be used to strengthen and improve the bulk of the vocal fold musculature and decrease compensatory supraglottic hyperfunction by balancing respiration, phonation, and resonance.

3. Resonance – Enhance/Maintain Voice Placement

Voice placement often changes due to a compensatory reaction to presbylaryngeus. It shifts from the ideal forward placement to a back focus which is often described as sounding raspy or gravely or simply muffled or fuzzy. This may couple with increased use of a glottal fry speaking pattern which requires minimal airflow for this phonation pattern, but in turn, does not support symmetric vocal fold vibration. This results in a popping or crackling sound to the voice and may worsen with vocal fatigue or overuse. Singers are often able to compensate for this until it becomes a big enough issue that is no longer able to be masked.

Recommendations: Voice placement issues can be targeted by improving the primary problem, presbylaryngeus, with VFEs. As the vocal fold strength improves, Resonant Voice exercises will be used to help re-establish a forward voice placement with an abdominal breath pattern across speech with a transition to appropriate resonant placement for their desired singing style.

Customizing Interventions

Voice Management

The studies presented in this dissertation have identified the realities and needs of the aging elite vocal performer. With this knowledge, I have proposed recommendations for training and care of this population. The goals for effective treatment of the aging singing voice are to prevent, preserve, and improve the voice. We address these goals by striving to *improve* the current quality with the initial therapy program, *preserve* the improvements with a maintenance plan that focuses on *preventing* additional aging decline to establish, once again, an efficient vocal mechanism. This is a system that has balance between respiration, phonation, and resonance and permits appropriate vocal quality, pitch, and loudness and meets the daily voicing needs of the singer, however demanding the task. This recommended voice management program for the aging elite vocal athlete addresses various changes to the three subsystems of respiration, phonation, and resonance to improve glottic closure, rebalance the laryngeal musculature, improve respiratory efficiency, and enhance vocal placement.

Target 1: Presbylaryngeus and Vocal Health and Care

The typical patient (as reflected in **Table 7.1**) presenting with these aging changes will complain of mild to moderate dysphonia with a weak, raspy vocal quality. Vocal complaints would include vocal fatigue with laryngeal aching (worse at the end of the day and after periods of increased voice use such as concerts or other vocally demand events), decreased upper range, gradually worsening hoarseness, decreased vocal clarity, difficulty getting loud, running out of breath with speech, and increased vocal instability. As these symptoms have progressed, the singer also states that their vocal changes are affecting their daily life as they have started reducing social participation and interactions due to these symptoms in order to try to preserve their voce for performance and high-demand events.

Table 7.1: Target patient: Aging elite vocal athlete with presbylaryngeus

• Bilateral atrophy of the true vocal folds, as demonstrated by prominent vocal processes and bowing of the vocal folds
• They attempted to compensate for the glottic insufficiency by increasing supraglottic hyperfunction. They were required to build greater subglottic air pressure to initiate and maintain vocal fold oscillation which required high airflow rates, however the singer had overall decreased respiratory efficiency. This resulted in a shift of vocal placement to a back vocal placement.

Table 7.2 shows the major aging changes in each subsystem of voice production that can be addressed with the voice management protocol.

Table 7.2: – Major aging changes addressed with the voice management protocol

Subsystem	Major Aging Change	Therapy Technique
Respiration	Respiratory Dysfunction	Abdominal focused breathing
Phonation	Glottal Insufficiency w/ secondary supraglottic hyperfunction	Vocal Function Exercises
Resonance	Back Vocal Focus	SOVT Exercises w/Resonant Voice

The vocal intervention target of the Exceptional Voice Protocol is addressed through using an eclectic voice therapy approach with a primary focus on physiologic voice therapy. Physiologic voice therapy is inherently a holistic approach to voice therapy as the therapy techniques attend to the three subsystems of voice production. More importantly, holistic voice therapy views the voice on a continuum from disordered (pathological) to supra-normal (the vocal professional, or exceptional voice) and is based on the belief that even the normal voice can be improved. This is an ideal fit for the aging elite vocal athlete since the diagnosis of presbylaryngeus is not considered a vocal pathology as aging is considered normal. However, as we have previously reviewed, there can be significant, and possibly severe, vocal symptoms associated with normative aging that result in dysphonia and vocal decline and the singers voice is not currently meeting their daily needs. Finally, a holistic voice therapy approach recognizes the importance of the patient accepting responsibility for improving/enhancing and maintaining their vocal health. This ownership of vocal improvement and health is mandatory for therapeutic change and continued success across the performance career and lifespan as the aging process continues.[284]

Exceptional Voice Protocol – Eclectic Approach Treatment Goals

1. Education on voice production and the overall goals of the therapy process
2. Abdominal focused breathing exercises to help increase awareness of breath placement.
3. Formal hydration program to improve laryngeal lubrication.
4. Semi-occluded vocal tract exercises to establish coordination of the three subsystems of voice production: phonation, respiration, and resonance and improve vocal fold vibration.
5. Vocal Function Exercises to improve vocal fold bulk and laryngeal muscle control, strength, and stamina, balance the three subsystems of voice production, and maximize glottal efficiency.
6. Resonant voice exercises to establish and maintain a forward tone focus.

Through the continued development of the *Exceptional Voice Protocol*, it is important to acknowledge the impact on vocal habilitation alongside the rehabilitation process to preserve vocal longevity. The most successful way to maintain and preserve vocal function is through regular and systematic vocal exercise. As component III found that using VFEs can even improve the normal aging voice, it is expected that using VFEs along with additional voice exercises, both with a therapeutic and habilitation focus for the vocal problems of aging elite vocal athletes (those with exceptional voices), will also improve and strengthen their voices. The following is a brief overview of the recommended exercises for each of the treatment goals.

Goals

Abdominal Focused Breathing & Education on Voice Production

As the breathing pattern often shifts from an abdominal focused breathing pattern to a thoracic-clavicular (or shallow/chest) breathing pattern as a means of compensation for perturbations in the vocal subsystems, a brief explanation of the anatomy and physiology of voice production and explanation of the three subsystems and how their diagnosis is disrupting the healthy balance is an ideal way to start the therapy process. This explanation will smoothly segue into an explanation of shallow/chest breathing versus abdominal focused breathing. Exercises targeting these two styles can be performed in the supine or sitting posture starting with resting breathing and then quickly integrated into voice production.

Formal Hydration Program

The singer would be recommended to increase fluid intake (primarily non-caffeinated beverages) to target ½ of their current body weight, in oz. If they are on any medications that have a drying effect, additional hydration throughout the day, including the use of steam inhalation or nebulized saline, is recommended to offset the drying effects of the medications. Increased laryngeal dryness can contribute to increased subglottic pressure required to initiate phonation.

SOVT Exercises

The goal of semi-occluded vocal tract (SOVT) exercises is to train source-filter interaction in an efficient and time-effective manner. When they are performed effectively, SOVT's work to maximize the interaction between the source and filter, resulting in increased vocal intensity, efficiency, and economy.[160] SOVT exercises are best incorporated by starting with exercises that use a greater degree of occlusion (1 = most artificial such as a smaller diameter straw) to a lesser degree of occlusion (11 = most speech like). One of the benefits of SOVT's is that there are multiple ways to perform them, and they can be easily modified and adapted to meet the needs and abilities of different patients. Another benefit, specifically for the presbylaryngeus patient population, is that this type of economy-oriented voice training reduces the potential for vocal injury, which is reduced if vibration dose and collision stress in the vocal folds are reduced[162] and can be easily incorporated into singing exercises.

Vocal Function Exercises

Vocal Function Exercises (VFEs) are a type of physiologic voice therapy comprising a series of voice manipulations designed to strengthen and balance the laryngeal muscles leading to an enhanced relationship of respiration, phonation, and resonance, thus improving vocal efficiency and voice quality.[169] The goal is to help improve glottic closure and rebalance the vocal mechanism leading to more efficient voicing.

Vocal Function Exercises consist of the four exercises (warm-up, stretching, contracting, and vocal power exercise) that are performed twice daily (morning and evening) with two repetitions each.

Resonant Voice Exercises

Resonant voice exercises strive to focus on the oral vibratory sensations during voice production while minimizing vocal fold impact while decreasing the risk of vocal injury. The goal of these exercises is to produce a strong, clear vocal quality with minimal vocal effort. The hierarchy of exercises start with sound productions that focus on an extreme forward placement (mmm) and increase in complexity to conversation. Variations of these exercises have been used in the theatrical and singing world as warm-ups and vocal exercises for numerous years and build on what is already recognized by many singers as good technique.

Singing Voice Exercises

We know that performers are not usually performing at 100% when at their most optimal levels, and they may have dropped to 50 or 60% of that when they are seeking clinical intervention. We also know that vocal exercises can improve vocal agility, accuracy, and endurance in the older singer. Adding singing voice exercises focusing on agility, flexibility, and stamina for the aging elite vocal athlete is recommended to train the voice for the required vocal demand.

Target II: Vocal and Performance Accommodations

Recommendations for performance and vocal accommodations should be specific to the performer, their vocal and performance style, and their needs. By the end of their careers, artists have generally already built up their "supportive skills". Bruce Springsteen acknowledged this in his book, *"My vocal imperfections made me work harder on my writing, my band leading, my performing and my singing. I learned to excel at those elements of my craft in a way I might otherwise never had if I had a more perfect instrument"*[217]. There are multiple different choices to use for accommodations, but some of the most successful ones observed in action are listed in **Table 7.3.**

Table 7.3: Vocal & performance accommodation examples

	Vocal & Performance Accommodations Examples
Additions	• Use more "performance" by others (i.e., Irish dance, harp, back-up singers, bring back opening acts, etc.) • Longer instrumental breaks in songs – highlight band members • More cover songs that are in the new range
Deletions	• Rewrite/cut out high notes that are too high • Remove movements that are no longer easy (kicks, spins, etc.)

	• Remove songs in catalog that are too hard/high
Distractions	• Have band members/back-up singers sing in unison to strengthen melody • Fill out sound with digital enhancement – backing vocals, reverb, etc. • Talk/sing if stamina is low • Have the audience sing along • Decrease the singer's mic volume on a bad night • Switch to an acoustic set for a lighter vocal demand • Kicking soccer balls into the crowd, other non-singing tasks

This is not a conclusive list as each choice will be specific for the artist, their genre, and the type of concert they want to perform. When working with aging elite vocal athletes, it is recommended to review multiple concerts from various points across their career to maintain the overall performance and vocal integrity of the singer while striving to re-shape their concert demands in their late career. It may be that many singers are already making similar accommodations to their vocal and performance changes without actually thinking about why they are doing what they are doing. What this protocol strives to accomplish is make the implicit less "taken for granted" and to identify additional ways to further improve vocal and performance efficiency. As they try out these accommodations, those that prove to be successful for the artist can be easily incorporated into their routine show. Many technical and performance strategies can be incorporated as they age to help accommodate for these changes and the focus should be on crafting a stage show that is not only financially viable, but also one that won't overload/overuse the voice and that provides their fans with another great memory of their beloved singer.

Table 7.4 provides an example of how the protocol would be used with an elite vocal athlete. The *Exceptional Voice Protocol* has been filled out for Bob Dylan targeting the vocal and performance needs that were observed in his sixth concert of Component IV.

Table 7.4: The Exceptional Voice Protocol Example

The Exceptional Voice Protocol

Name: Bob Dylan **Date:** 11/24/2016

Areas of concern: Pitch range, vocal instability, breath support, phrasing, timing, articulation

Respiratory Efficiency: Increase Maintain

MPT: 10 seconds VC: 3.0 L/sec PTP: 2.8 cm H20

Recommendations: Improve coordination of airflow with phonation

Phonation – Glottic Closure: Increase Maintain

Closure pattern: Spindle shaped Hyper/Hypofunction MW: Increased/Decreased

Recommendations: Increase glottic closure, improve vocal efficiency

Resonance – Voice Placement: Increase Maintain

Forward/Back Resonance shift: Y/N Other: Unclear articulation

Recommendations: Improve articulation, increase forward vocal placement

Current Hydration: Less than ideal - recommend improved hydration

Vocal Hygiene Areas of Need: Reduced vocal demand on show days, increase vocal breaks, decrease smoking

Vocal Exercise Plan:

1. *Respiration:* Vocal Function Exercises to recoordinate respiration, phonation, and resonance. Improve glottic closure and increase vocal efficiency. Target breath support across vocal lines and phrasing.
2. *Phonation:* Modify VFEs to target vocal stamina and flexibility. Use SOVTs with vocal exercises (1/2 steps progressing to larger interval) for additional vocal exercise targeting decreased laryngeal strain
3. *Resonance:* Resonant Voice/singing voice placement targeted to concert rep. Additional focus on articulation stylized to match early recordings.

Performance Areas of Concern: Noted to use little to no vocal phrasing or breath support. Staccato like singing with no clear melody. Better articulation with cover songs.

Performance Recommendations:

1. *Additions:* Concerts are primarily 60% instrumental - consider adding back-up singers
2. *Deletions:* Already overdoing deletions - considering decreasing deletions and maintaining more of the original catalog with modifications.
3. *Distractions:* Use band members/back-up singers to double melody and carry the higher notes.

Bob Dylan's performance on 11/24/2016 revealed multiple vocal and performance areas of weakness. Overall vocal goals focused on increasing respiratory, vocal, and resonance efficiency while strengthening the vocal mechanism. Vocal hygiene needs were targeted with recommendations for improvement. Overall performance goals included recommendations in the three categories of additions, deletions, and distractions to address the performance areas of concern. This concert protocol would be trialed and changes would be recommended based on the success of the changes in his overall concert. Protocol recommendations would likely change based on his continued performance experiences, always with the overall goal of identifying any areas of weakness and addressing them through a combination of exercise and accommodations.

This model for the aging CCM performer was designed to help reverse aging changes when possible, maintain, and when unavoidable, accommodate to such changes in a way that is financially viable, sustainable, and efficacious as they continue to perform in their twilight years. While the example was shown using Bob Dylan, it can be used with any singers, professional or avocational, and any vocal style. The most critical piece of the protocol is the focus on creating a customized vocal & performance blueprint for each artist that meets their unique needs for their exceptional voice so they can continue performing for as long as they desire.

Future Directions

This dissertation research is an integral piece of subsequent post-doctoral study which will examine the lived experiences of aging elite vocal athletes and how to prevent, preserve and improve voice production as well as employ a variety of performance modification strategies to increase effecting longevity as a singer. The following section contains a brief overview of future research ideas.

- *VFE modifications for singers* – Vocal Function Exercises are well researched with treatment efficacy documented for multiple vocal pathologies as well as for the normal and aging voice. As aging elite vocal athletes have exceptional voices, exceptional treatment is required. This study would compare the classic VFE routine to an exercise routine with either increased exercise intensity or increased vocal range.
- *VFE time to Return to Perform* – Singers have to work-out harder and longer than the average vocal user since their vocal demands are much higher. Research typically examines an intervention method for approximately 6 weeks. Clinically, we know that these patients are not "back to their normal" at 6 weeks. This study would follow multiple aging elite vocal athletes and measure how long they need to perform VFEs until their vocal complaints are no longer applicable. This same research idea could be implemented with singers vs. non-singers to see if there is a difference in average time between these two groups.
- *Component IV expansion* – The final study could be expanded to multiple performers with more timepoints across their career to assess the following variables:
    - percent sang
    - vocal and performance accommodations across the lifespan. With multiple singers, this study could explore age, cohort, and period effects.

    - differences related to sex
    - differences between various classifications of singing genres (i.e., classical, pop, country, rock)
    - Awareness of the singers to the accommodations and if their performance changes when this is revealed to them
    - Accommodation strategies for outdoor vs. indoor concert venues
    - Accommodation changes dependent of time off between concert
    - Accommodation changes based on the beginning vs end of the tours
- *Younger Generation Aging* – Are younger singers currently using any of the vocal and performance accommodations and how does this change as they age? What changes do we see in the younger generation of artists?
- *Vocal Rest* – How do the voice and performance abilities of the elite vocal athletes change based on how much vocal rest they get between concerts?
- *Audience response* – How much does the price of the ticket influence the expectations of the audience when it pertains to the overall vocal and performance quality of the singer?
- *Performing Sober* – CCM singers often decrease/quit illicit drug, smoking, and alcohol as they age. What is the impact of this on their performance? Do they face any issues when "learning how to sing sober" when they are already internationally recognized artists?
- *Cancellation of Concerts* – Do singers concert cancellation rate increase as they age? And if so, what impact does this have on their career?

Conclusion

We must remember that these study findings are gathered from the world of contemporary commercial music by artists who all, by definition, have exceptional voices[272]. Some learn their styles through classical training, and some learn through life and performance experience. All singers' journeys are different and unique and it is these different journeys that make them so different and unique. You can't easily go to school to learn how to sing like Bob Dylan or Rod Stewart. Because their styles are so unique, these results can only be applied to this genre of artists, and more specifically, these individual artists. There are moral obligations that we, as fans, need to better meet as our beloved rock stars age. We must remember that these singers are just that…singers. They love music and they love sharing their talent with the world. While they may live the lives of internationally acclaimed musicians, it is important to remember they are just human, and they are not excluded from the ravages of time. While many musicians desire to perform as long as they physically are able, as the audience, we can help them do this with grace and dignity by accepting the changes in their vocal and performance styles and embracing the accommodations they put in place as they keep on performing. We also have an opportunity to contribute positively to the fight against ageism in our society and to evolve this into a new "non-ageist" recognition of the continued talents of our older singers.

The focus of this dissertation is deeply rooted in the balance of artistic knowledge and understanding of what the singers are experiencing as age-related vocal and performance changes, the clinical understanding of the voice production mechanism and subsystems that can all be affected by these changes, and appropriate rehabilitation recommendations. This understanding demanded that this dissertation integrate both a clinical and artistic rehabilitation approach to create the *Exceptional Voice Protocol* as the artistic and scientific changes cannot be truly separated in real life for this unique population of aging elite vocal athletes. Because of this, the *Exceptional Voice Protocol* involves the two integrated components of vocal intervention and performance adjustment into the overall treatment focus. From an artistic and clinical standpoint, following the *Exceptional Voice Protocol* will help voice specialist speech-language pathologists and other care team providers customize a vocal habilitation and rehabilitation program with a special focus on performance and vocal accommodations as they are needed by the artist. After all, the ultimate goal is to keep our exceptional singers exceptional, not just in “some form” or “any form” but in the **best form** possible during the final act of their career.

APPENDICES

Appendix A - Autobiographies/Memoirs

Singer	Year	Title	Genre	Comments
Toni Braxton	2014	*Unbreak My Heart: A Memoir*245	R&B/Soul	
Jimmy Buffett	1998	*A Pirate Looks at 50*285	Easy Listening	Nothing
Carol Burnett	2010	*This Time Together: Laughter and Reflection*286	Musical Theater	Nothing
Judy Collins	2011	*Sweet Judy Blue Eyes*287	Folk/Pop	Nothing
Phil Collins	2016	*Not Dead Yet*221	Traditional Pop/Soft Rock	
Elvis Costello	2015	*Unfaithful Music and Disappearing Ink*288	Punk Rock	Nothing
Alan Cumming	2014	*Not My Father's Son*289	Musical Theater	
Alan Cumming	2016	*You Got to Get Bigger Dreams: My Life In Stories and Pictures*220	Musical Theater	
Bob Dylan	2004	*Chronicles, Vol. 1*229	Folk/Pop	
Kim Gordon		*Girl in a Band*216	Alt. Rock	
Woodie Guthrie	1968	*Bound for Glory*290	American Folk	
Billy Idol	2014	*Dancing with Myself*246	Punk Rock	
Tom Jones	2015	*Over the Top and Back: The Autobiography*240	Pop Rock	Nothing
Carole King	2012	*A Natural Women: A Memoir*235	Pop/Soul	
Mike Love	2016	*Good Vibrations: My Life as a Beach Boy*242	Rock/Pop	
Shirley MacLaine	2013	*What If*291	Musical Theater	Nothing
Willie Nelson	2012	*Roll Me Up and Smoke Me When I Die*292	Country	
Dolly Parton	1994	*Dolly: My Life and Other Unfinished Business*293	Country	
Linda Ronstadt	2013	*Simple Dreams: A Musical Memoir*243	Pop/Country	
Carly Simon	2015	*Boys in the Trees: A Memoir*294	Pop Rock	
Bruce Springsteen	2016	*Born to Run*217	Rock	
Paul Stanley	2014	*Face the Music: A Life Exposed*295	Hard Rock/Heavy Metal	
Rod Stewart	2012	*Rod: The Autobiography*212	Rock/Pop	
Dick Van Dyke	2011	*My Lucky Life In and Out of Show Business: A Memoir*296	Musical Theater	
Dick Van Dyke	2015	*Keep Moving: And Other Tips and Truths About Aging*297	Musical Theater	Nothing
Andy Williams	2009	*Moon River and Me: A Memoir*237	Easy Listening	
Neil Young	2012	*Waging Heavy Peace: A Hippie Dream*234	Folk Rock/Country	

Appendix B - Autobiographies – with Ghostwriter

Singer	(Ghostwriter)	Year	Title	Genre	Comments on Voice
Gregg Allman	w/ Alan Light	2012	*My Cross to Bear*[227]	Blues/Southern Rock	
Tony Bennett	w/ Mitch Albom	2012	*Life is a Gift*[226]	Pop/Easy Listening	
Tony Bennett	w/ Scott Simon	2106	*Just Getting Started*[236]	Traditional Pop	Nothing
Chuck Berry	w/ Bruce Springsteen	1988	*The Autobiography*[298]	Rock and Roll	
Johnny Cash	w/ Patrick Carr	1997	*Cash: The Autobiography*[225]	Country	
Peter Criss	w/ Larry Sloman	2012	*Makeup to Breakup*[238]	Hard Rock/Heavy Meta.	
Clive Davis	w/ Anthony DeCurtis	2012	*The Soundtrack of My Life*[269]	Producer	Nothing
Mick Fleetwood	w/ Anthony Bozza	2014	*Now, Then, and Fleetwood Mac Plays On*[239]	Pop Rock	
John Fogarty	w/ Jimmy McDonough	2015	*Fortunate Son: My Live, My Music*[299]		
Waylon Jennings	w/ Lenny Kaye	1996	*Waylon*[300]	Country Rock	
Shirley Jones	w/ Wendy Leigh	2013	*A Memoir*[301]	Traditional Pop	Nothing
Naomi Judd	w/ Marcia Wilkie	2016	*River of Time*[230]	Country	
B.B. King	w/ David Ritz	1996	*Blues All Around Me: The Autobiography of B.B. King*[231]	Blues	
Bill Kreutzmann	w/ Benji Eisen	2015	*Deal: My Three Decades Drumming, Dreams, and Drugs with the Grateful Dead*[302]	Rock	Nothing
Loretta Lynn	w/ George Vecsey	1976	*Coal Miner's Daughter*[303]	Country	Nothing
Willie Nelson	w/ Edwin Shrake	1988	*Willie, An Autobiography*[304]	Country	
Willie Nelson	w/ David Ritz	2015	*It's a Long Story: My Life*[305]	Country	
Joe Perry	w/ David Ritz	2014	*Rocks: My Life In and Out of Aerosmith*[228]	Hard Rock	
Debbie Reynolds	w/ Dorian Hannaway	2013	*Unsinkable: A Memoir*[306]	Musical Theater	
Keith Richards	w/ James Fox	2010	*Life*[232]	Rock/Blues	
Tina Sinatra	w/ Jeff Coplon	2000	*My Father's Daughter: A Memoir*[247]	Traditional Pop	
Ricky Skaggs	w/ Eddie Dean	2013	*Kentucky Traveler – My Life in Music*[222]	Country/Bluegrass	
Brian Wilson	w/ Ben Greenman	2016	*I am Brian Wilson: A Memoir*[244]	Rock/Pop	
Frank Zappa	w/ Peter Occhiogrosso	1989	*The Real Frank Zappa Book*[307]		

Appendix C - Biographies

Singer	Author	Year	Title	Genre	Comments on Voice
Johnny Cash	Robert Hillburn	2013	*Johnny Cash: The Life*[308]	Country	
Cher	Daryl Easlea and Eddi Figel	2013	*Cher: All I Really Want to Do*[241]	Pop/Disco	
Bob Dylan	Dennis McDougal	2014	*Dylan: The Biography*[270]	Folk/Pop	
Duke Ellington	Terry Teachout	2013	*Duke: A Life of Duke Ellington*[309]	Jazz	
Aretha Franklin	David Ritz	2015	*Respect*[260]	R&B/Soul	
Elton John	David Buckley	2007	*Elton John: The Biography*[262]	Pop Rock	
Billie Holiday	John Szwed	2015	*Billie Holiday: The Musician and the Myth*[223]	Blues	
Mick Jagger	Philip Norman	2012	*Mick Jagger*[310]	Pop/Rock/Blues	
Mick Jagger	Christopher Andersen	2012	*Mick: The Wild Life and Mad Genius of Jagger*[311]	Pop/Rock/Blues	
Billy Joel	Fred Schruers	2014	*Billy Joel: The Definitive Biography*[219]	Soft Rock/Pop	
Eartha Kitt	John Williams	2014	*America's Mistress: The Life and Times of Eartha Kitt*[312]	Jazz	Nothing
Jerry Lee Lewis	Rick Bragg	2014	*Jerry Lee Lewis: His Own Story*[224]	Rock and Roll	
Paul McCartney	Howard Sounes	2010	*Fab: An Intimate Life of Paul McCartney*[313]	Pop Rock	
Paul McCartney	Phillip Norman	2016	*Paul McCartney - The Life*[314]	Pop Rock	
Paul McCartney	Paul Du Noyer	2015	*Conversations with McCartney*[315]	Pop Rock	
Tom Petty	Warren Zanes	2015	*Petty: The Biography*[316]	Rock	
Elvis Presley	Ginger Alden	2014	*Elvis and Ginger*[317]	Rock and Roll	
Keith Richards	Egan Sean	2013	*Keith Richards on Keith Richards – Conversations and Interviews*[318]	Rock/Blues	
Paul Simon	Cornel Bonca	2015	*Paul Simon: an American Tune*[319]	Folk/Rock/Pop	Nothing
Frank Sinatra	Kitty Kelley	1986	*His Way: An Unauthorized Biography*[261]	Traditional Pop	
Frank Sinatra	David Lehman	2015	*Sinatra's Century: One Hundred Notes on the Man and His World*[218]	Traditional Pop	
Frank Sinatra	J. Randy Taraborrelli	2015	*Sinatra: Behind the Legend*[233]	Traditional Pop	
Barbara Streisand	Neal Gabler	2016	*Barbara Streisand: Redefining Beauty, Femininity and Power*[320]	Musical Theater/Jazz	

Appendix D – Study Data Sheet – Initial

DATE:___________________

Please circle 'yes; for each item that has been completed

Subject #: Exercise A / Exercise B (circle 1) ______ (number)
Informed consent: Yes / No

VHI: Yes / No: **Score**: Physical: ______ , Functional: ______, Emotional: ______ , Total: ______

Phonatory Effort Scale: ________

Vocal Severity Scale: ________

CAPE-V: Yes / No

Overall quality	
Pitch	
Loudness	
Breathiness	

Acoustics: Yes/No

F_o	
Jitter	
Shimmer	
NHR	
Maximum Phonation Time	
CSID for /a/	
CSID for easy onset sentences	
CSID for voiced plosive sentences	
CSID for hard glottal attack sentences	
CSID for All voiced sentences	

Aerodynamics: Yes/No

Vital capacity	
Mean airflow during voicing	
Mean peak air pressure	
Airway resistance	
Phonation threshold pressure	

Strobe: Yes / No
Circle one:

Glottic Closure
0= no gap / 1= small gap / 2= large gap

Anterior gap / Posterior gap / Spindle shaped gap

Mucosal Wave
Normal / Slightly reduced / Moderately to severely reduced

Symmetry
Symmetrical / Slightly asymmetrical / Moderately to severely asymmetrical

High Speed Laryngeal imaging: Yes / No

Circle one:

Glottic Closure
0= no gap / 1= small gap / 2= large gap

Anterior gap / Posterior gap / Spindle shaped gap

Mucosal Wave
Normal / Slightly reduced / Moderately to severely reduced

Symmetry
Symmetrical / Slightly asymmetrical / Moderately to severely asymmetrical

Speech Breathing Assessment: yes / no

Treatment Sessions:

Week one: yes / no

Week two: yes / no

Week three: yes / no

Week four: yes / no

Week five: yes / no

Week six: yes / no

Appendix E – Study Data Sheet – Post-Therapy

Date:__________________

Participant #:___________

VHI: Yes / No: **Score**: Physical: _____ , Functional: _____, Emotional: _____ , Total: _____

Phonatory Effort Scale: _______

Vocal Severity Scale: _______

CAPE-V: Yes / No

Overall quality	
Pitch	
Loudness	
Breathiness	
Strain	
Roughness	

Acoustics: Yes/No

F_o	
Jitter	
Shimmer	
NHR	
Maximum Phonation Time	
CSID for /a/	
CSID for easy onset sentences	
CSID for voiced plosive sentences	
CSID for hard glottal attack sentences	
CSID for All voiced sentences	

Aerodynamics: Yes/No

Vital capacity	
Mean airflow during voicing	
Mean peak air pressure	
Airway resistance	
Phonation threshold pressure	

Strobe: Yes / No
Circle one:

Glottic Closure
0= no gap / 1= small gap / 2= large gap

Anterior gap / Posterior gap / Spindle shaped gap

Mucosal Wave
Normal / Slightly reduced / Moderately to severely reduced

Symmetry
Symmetrical / Slightly asymmetrical / Moderately to severely asymmetrical

High Speed Laryngeal Imaging: Yes / No

Circle one:

Glottic Closure
0= no gap / 1= small gap / 2= large gap

Anterior gap / Posterior gap / Spindle shaped gap

Mucosal Wave
Normal / Slightly reduced / Moderately to severely reduced

Symmetry
Symmetrical / Slightly asymmetrical / Moderately to severely asymmetrical

Appendix F – Study Data Sheet – One Month

Date:__________________

Participant #:___________

VHI: Yes / No: **Score**: Physical: ______ , Functional: ______, Emotional: ______ , Total: ______

Phonatory Effort Scale: ________

Vocal Severity Scale: ________

CAPE-V: Yes / No

Overall quality	
Pitch	
Loudness	
Breathiness	
Strain	
Roughness	

Acoustics: Yes/No

F_o	
Jitter	
Shimmer	
NHR	
Maximum Phonation Time	
CSID for /a/	
CSID for easy onset sentences	
CSID for voiced plosive sentences	
CSID for hard glottal attack sentences	
CSID for All voiced sentences	

Aerodynamics: Yes/No

Vital capacity	
Mean airflow during voicing	
Mean peak air pressure	
Airway resistance	
Phonation threshold pressure	

Strobe: Yes / No
Circle one:

Glottic Closure
0= no gap / 1= small gap / 2= large gap

Anterior gap / Posterior gap / Spindle shaped gap

Mucosal Wave
Normal / Slightly reduced / Moderately to severely reduced

Symmetry
Symmetrical / Slightly asymmetrical / Moderately to severely asymmetrical

High Speed Laryngeal Imaging: Yes / No

Circle one:

Glottic Closure
0= no gap / 1= small gap / 2= large gap

Anterior gap / Posterior gap / Spindle shaped gap

Mucosal Wave
Normal / Slightly reduced / Moderately to severely reduced

Symmetry
Symmetrical / Slightly asymmetrical / Moderately to severely asymmetrical

Appendix G - Mini-Cog Instructions

1. Say the following three words to the participant and tell him/her to remember the words for later
    a. **Airplane**
    b. **Locker**
    c. **Wagon**

2. Give the subject a blank sheet of paper. Ask him/her to:
    a. "**Draw the face of a clock"**
    b. "Set the time for ten minutes after eleven" (11:10)

3. When the client has completed the clock drawing, ask him/her to repeat the three words given at the beginning of the task.

Scoring:
Participant gets 1 point for each word recalled correctly (3 points possible).
Participant receives 1 point if the face of the clock is correct (all 12 numbers on the clock).
Participant gets 1 point in the time on the clock is correct (11:10).

Total of 5 points possible

A score of 3+ is required to pass the Mini-Cog.

Appendix H – Voice Handicap Index (VHI)

These are statements that many people have used to describe their voices and the effects of their voices on their lives. Circle the response that indicates how frequently you have the same experience.

0-never 1-almost never 2-sometimes 3-almost always 4-always

Part I-F

My voice makes it difficult for people to hear me.	**0**	**1**	**2**	**3**	**4**
People have difficulty understanding me in a noisy room.	**0**	**1**	**2**	**3**	**4**
My family has difficulty hearing me when I call them throughout the house.	**0**	**1**	**2**	**3**	**4**
I use the phone less often than I would like to.	**0**	**1**	**2**	**3**	**4**
I tend to avoid groups of people because of my voice.	**0**	**1**	**2**	**3**	**4**
I speak with friends, neighbors, or relatives less often because of my voice.	**0**	**1**	**2**	**3**	**4**
People ask me to repeat myself when speaking face-to-face.	**0**	**1**	**2**	**3**	**4**
My voice difficulties restrict my personal and social life.	**0**	**1**	**2**	**3**	**4**
I feel left out of conversation because of my voice.	**0**	**1**	**2**	**3**	**4**
My voice problems cause me to lose income.	**0**	**1**	**2**	**3**	**4**

SUBTOTAL _________

Part II-P

I run out of air when I talk.	**0**	**1**	**2**	**3**	**4**
The sound of my voice varies throughout the day.	**0**	**1**	**2**	**3**	**4**
People ask, "What's wrong with your voice?"	**0**	**1**	**2**	**3**	**4**
My voice sounds creaky and dry.	**0**	**1**	**2**	**3**	**4**
I feel as though I have to strain to produce voice.	**0**	**1**	**2**	**3**	**4**
The clarity of my voice is unpredictable.	**0**	**1**	**2**	**3**	**4**
I try to change my voice to sound different.	**0**	**1**	**2**	**3**	**4**
I use a great deal of effort to speak.	**0**	**1**	**2**	**3**	**4**
My voice is worse in the evening.	**0**	**1**	**2**	**3**	**4**
My voice "gives out" on me in the middle of speaking.	**0**	**1**	**2**	**3**	**4**

SUBTOTAL _________

Part III-E

I am tense when talking to others because of my voice.	**0**	**1**	**2**	**3**	**4**
People seem irritated with my voice.	**0**	**1**	**2**	**3**	**4**
I find other people don't understand my voice problem.	**0**	**1**	**2**	**3**	**4**
My voice problem upsets me.	**0**	**1**	**2**	**3**	**4**
I am less outgoing because of my voice problem.	**0**	**1**	**2**	**3**	**4**
My voice makes me feels handicapped.	**0**	**1**	**2**	**3**	**4**
I feel annoyed when people ask me to repeat.	**0**	**1**	**2**	**3**	**4**
I feel embarrassed when people ask me to repeat.	**0**	**1**	**2**	**3**	**4**
My voice makes me feel incompetent.	**0**	**1**	**2**	**3**	**4**
I am aASPed of my voice problem.	**0**	**1**	**2**	**3**	**4**

SUBTOTAL _________ **TOTAL _________**

The Voice Handicap Index (VHI): Development and Validation
Barbara H. Jacobson, Alex Johnson, Cynthia Grywalski, Alice Silbergleit, Gary Jaconsen, Michael S. Benninger
American Journal of Speech-Language Pathology, Vol 6(3), 66-70, 1997, The Voice Handicap Index is reprinted with permission from all authors and ASHA.

Appendix I - Phonatory Effort and Vocal Severity Scales

Please read the following passage out loud and rate your vocal effort and severity on the scale below:

When the sunlight strikes raindrops in the air, they act as a prism and form a rainbow. The rainbow is a division of white light into many beautiful colors. These take the shape of a long round arch, with its path high above, and its two ends apparently beyond the horizon.

________ 0 = No Effort

________ 1 = Minimal Effort

________ 2 = Moderate Effort

________ 3 = Severe Effort

Please judge vocal severity:

________ 0 = Normal

________ 1 = Mild

________ 2 = Moderate

________ 3 = Severe

Appendix J – Consensus Auditory-Perceptual Evaluation of Voice (CAPE-V)

Consensus Auditory-Perceptual Evaluation of Voice (CAPE-V)

Name:____________________________ **Date:**__________

The following parameters of voice quality will be rated upon completion of the following tasks:

1. Sustained vowels, /a/ and /i/ for 3-5 seconds duration each.
2. Sentence production:
   a. The blue spot is on the key again.
   b. How hard did he hit him?
   c. We were away a year ago.
   d. We eat eggs every Easter.
   e. My mama makes lemon muffins.
   f. Peter will keep at the peak.
3. Spontaneous speech in response to: "Tell me about your voice problem." or "Tell me how your voice is functioning."

Legend: C = Consistent I = Intermittent
MI = Mildly Deviant
MO =Moderately Deviant
SE = Severely Deviant

					SCORE
Overall Severity	________ MI MO SE	C	I		___/100
Roughness	________ MI MO SE	C	I		___/100
Breathiness	________ MI MO SE	C	I		___/100
Strain	________ MI MO SE	C	I		___/100
Pitch	(Indicate the nature of the abnormality): ________ ________ MI MO SE	C	I		___/100
Loudness	(Indicate the nature of the abnormality): ________ ________ MI MO SE	C	I		___/100
________	________ MI MO SE	C	I		___/100
________	________ MI MO SE	C	I		___/100

COMMENTS ABOUT RESONANCE: NORMAL OTHER (Provide description):________________

____

ADDITIONAL FEATURES (for example, diplophonia, fry, falsetto, asthenia, aphonia, pitch instability, tremor, wet/gurgly, or other relevant terms):

Clinician:__________________

Appendix K – Rainbow Passage

When the sunlight strikes raindrops in the air, they act like a prism and form a rainbow. The rainbow is a division of white light into many beautiful colors. Theses take the shape of a long round arch, with its path high above, and its two ends apparently beyond the horizon.

Appendix L - Vocal Fold Parameters Ratings

Glottic Closure

_________ 0 = No Gap

_________ 1 = Small Gap

_________ 2 = Large Gap

_________ Anterior Gap

_________ Posterior Gap

_________ Spindle Shaped Gap

Mucosal Wave

_________ Normal

_________ Slightly Reduced

_________ Moderately to Severely Reduced

Symmetry

_________ Symmetrical

_________ Slightly Asymmetrical

_________ Moderate to Severely Asymmetrical

Appendix M - Exercise A Protocol (VFE)

1. Sustain /i/ as long as possible on the musical note assigned.
2. Glide from the lowest to the highest note in the frequency range, using /o/
3. Glide from the highest to the lowest note in the frequency range, using /o/
4. Sustain the musical notes assigned for as long as possible using /o/

Repeat all exercises two times each, twice a day. Produce all tones softly, with a forward focus.

Appendix N - Exercise B Protocol (Control)

1. Read a short passage using your comfortable conversation pitch.

2. Chant the sentences in group 1. (Plosives)
    a. Keep the book in your backpack.
    b. Take the bread to the ducks.
    c. The baby is playing peek-a-boo.
    d. Go pack the blue car.
    e. Time is quickly ticking away.

3. Chant the sentences in group 2. (Fricatives)
    a. The fairy placed a flower in the vase.
    b. There is a very fine view from the roof.
    c. The five verses were easy.
    d. The vacant room was dark.
    e. The rose was free of thorns.

4. Chant the sentences in group 3. (Sibilants)
    a. I eat cherries and cheese.
    b. Sissy sees the sun in the sky.
    c. She saw a sheep and a goose at the zoo.
    d. Did you see me leave my shoes by the hose?
    e. Sherry went shopping.

5. Chant the sentences in group 4. (Nasals)
    a. My mother made lemon jam.
    b. Marty is mad at Nancy.
    c. Neither Mary nor Mona ran.
    d. Mark will be marrying Pam.
    e. The merry man wore green.

Repeat all exercises two times each, twice a day.

Appendix O – VFE Group Practice Log

Week 1			1st Day	2nd	3rd	4th	5th	6th	7th
		DATE							
	1	**“eee”** *Sustain the vowel “eee” for as long as you can. Placement should be extremely forward, very nasal. Do this as softly as possible, but not breathy. Engage the voice. This is a warm-up. Time this exercise. Record times for two attempts below.*							
			/	/	/	/	/	/	/
	2	**Glide from your lowest note to your comfortable highest on “knoll.”** *The goal is no voice breaks with buzzing in the lips and steady airflow. Check off two attempts for this exercise. You do not need to time this exercise or measure pitch.*							
AM			**1 2**	**1 2**	**1 2**	**1 2**	**1 2**	**1 2**	**1 2**
	3	**Glide from a comfortable high pitch to your lowest pitch on “knoll”.** *The goal is no voice breaks with buzzing in the lips and steady airflow. Check off two attempts for this exercise. You do not need to time this exercise or measure pitch.*							
			1 2	**1 2**	**1 2**	**1 2**	**1 2**	**1 2**	**1 2**
	4	**Sustain the following five ascending pitches for as long as possible using the buzzy “knoll”.** *Keep the airflow steady and time this exercise. Record the time for the two attempts below.*							
		Pitch 1	/	/	/	/	/	/	/
		Pitch 2	/	/	/	/	/	/	/
		Pitch 3	/	/	/	/	/	/	/
		Pitch 4	/	/	/	/	/	/	/
		Pitch 5	/	/	/	/	/	/	/
	1	**“eee”**	/	/	/	/	/	/	/
	2	**Ascending Glide**	**1 2**	**1 2**	**1 2**	**1 2**	**1 2**	**1 2**	**1 2**
	3	**Descending Glide**	**1 2**	**1 2**	**1 2**	**1 2**	**1 2**	**1 2**	**1 2**
PM	4	**Pitch 1**	/	/	/	/	/	/	/
		Pitch 2	/	/	/	/	/	/	/
		Pitch 3	/	/	/	/	/	/	/
		Pitch 4	/	/	/	/	/	/	/
		Pitch 5	/	/	/	/	/	/	/

Week 2		DATE							
AM	1	**"eee"**	/	/	/	/	/	/	/
	2	**Ascending Glide**	1 2	1 2	1 2	1 2	1 2	1 2	1 2
	3	**Descending Glide**	1 2	1 2	1 2	1 2	1 2	1 2	1 2
	4	**Pitch 1**	/	/	/	/	/	/	/
		Pitch 2	/	/	/	/	/	/	/
		Pitch 3	/	/	/	/	/	/	/
		Pitch 4	/	/	/	/	/	/	/
		Pitch 5	/	/	/	/	/	/	/
PM	1	**"eee"**	/	/	/	/	/	/	/
	2	**Ascending Glide**	1 2	1 2	1 2	1 2	1 2	1 2	1 2
	3	**Descending Glide**	1 2	1 2	1 2	1 2	1 2	1 2	1 2
	4	**Pitch 1**	/	/	/	/	/	/	/
		Pitch 2	/	/	/	/	/	/	/
		Pitch 3	/	/	/	/	/	/	/
		Pitch 4	/	/	/	/	/	/	/
		Pitch 5	/	/	/	/	/	/	/
Week 3		**DATE**							
AM	1	**"eee"**	/	/	/	/	/	/	/
	2	**Ascending Glide**	1 2	1 2	1 2	1 2	1 2	1 2	1 2
	3	**Descending Glide**	1 2	1 2	1 2	1 2	1 2	1 2	1 2
	4	**Pitch 1**	/	/	/	/	/	/	/
		Pitch 2	/	/	/	/	/	/	/
		Pitch 3	/	/	/	/	/	/	/
		Pitch 4	/	/	/	/	/	/	/
		Pitch 5	/	/	/	/	/	/	/
PM	1	**"eee"**	/	/	/	/	/	/	/
	2	**Ascending Glide**	1 2	1 2	1 2	1 2	1 2	1 2	1 2
	3	**Descending Glide**	1 2	1 2	1 2	1 2	1 2	1 2	1 2
	4	**Pitch 1**	/	/	/	/	/	/	/
		Pitch 2	/	/	/	/	/	/	/
		Pitch 3	/	/	/	/	/	/	/
		Pitch 4	/	/	/	/	/	/	/
		Pitch 5	/	/	/	/	/	/	/

Week 4		DATE							
AM	1	"eee"	/	/	/	/	/	/	/
	2	Ascending Glide	1 2	1 2	1 2	1 2	1 2	1 2	1 2
	3	Descending Glide	1 2	1 2	1 2	1 2	1 2	1 2	1 2
	4	Pitch 1	/	/	/	/	/	/	/
		Pitch 2	/	/	/	/	/	/	/
		Pitch 3	/	/	/	/	/	/	/
		Pitch 4	/	/	/	/	/	/	/
		Pitch 5	/	/	/	/	/	/	/
PM	1	"eee"	/	/	/	/	/	/	/
	2	Ascending Glide	1 2	1 2	1 2	1 2	1 2	1 2	1 2
	3	Descending Glide	1 2	1 2	1 2	1 2	1 2	1 2	1 2
	4	Pitch 1	/	/	/	/	/	/	/
		Pitch 2	/	/	/	/	/	/	/
		Pitch 3	/	/	/	/	/	/	/
		Pitch 4	/	/	/	/	/	/	/
		Pitch 5	/	/	/	/	/	/	/
Week 5		DATE							
AM	1	"eee"	/	/	/	/	/	/	/
	2	Ascending Glide	1 2	1 2	1 2	1 2	1 2	1 2	1 2
	3	Descending Glide	1 2	1 2	1 2	1 2	1 2	1 2	1 2
	4	Pitch 1	/	/	/	/	/	/	/
		Pitch 2	/	/	/	/	/	/	/
		Pitch 3	/	/	/	/	/	/	/
		Pitch 4	/	/	/	/	/	/	/
		Pitch 5	/	/	/	/	/	/	/
PM	1	"eee"	/	/	/	/	/	/	/
	2	Ascending Glide	1 2	1 2	1 2	1 2	1 2	1 2	1 2
	3	Descending Glide	1 2	1 2	1 2	1 2	1 2	1 2	1 2
	4	Pitch 1	/	/	/	/	/	/	/
		Pitch 2	/	/	/	/	/	/	/
		Pitch 3	/	/	/	/	/	/	/
		Pitch 4	/	/	/	/	/	/	/
		Pitch 5	/	/	/	/	/	/	/

Week 6		DATE							
AM	1	**“eee”**	/	/	/	/	/	/	/
	2	**Ascending Glide**	1 2	1 2	1 2	1 2	1 2	1 2	1 2
	3	**Descending Glide**	1 2	1 2	1 2	1 2	1 2	1 2	1 2
	4	**Pitch 1**	/	/	/	/	/	/	/
		Pitch 2	/	/	/	/	/	/	/
		Pitch 3	/	/	/	/	/	/	/
		Pitch 4	/	/	/	/	/	/	/
		Pitch 5	/	/	/	/	/	/	/
PM	1	**“eee”**	/	/	/	/	/	/	/
	2	**Ascending Glide**	1 2	1 2	1 2	1 2	1 2	1 2	1 2
	3	**Descending Glide**	1 2	1 2	1 2	1 2	1 2	1 2	1 2
	4	**Pitch 1**	/	/	/	/	/	/	/
		Pitch 2	/	/	/	/	/	/	/
		Pitch 3	/	/	/	/	/	/	/
		Pitch 4	/	/	/	/	/	/	/
		Pitch 5	/	/	/	/	/	/	/

From: Stemple J, Roy, N, Klaben B. *Clinical Voice Pathology: Theory and Management*. 6th ed. San Diego: Plural Publishing; 2019.

Appendix P – Control Group Practice Log

Week 1			1st Day	2nd	3rd	4th	5th	6th	7th
		DATE							
AM	1	Read a short passage using your comfortable speaking pitch. Check the box below to indicate completion of the task.							
	2	Chant the following five groups of sentences twice each. Cross off each attempt below to indicate completion of the task.							
		Group 1	1 2	1 2	1 2	1 2	1 2	1 2	1 2
		Group 2	1 2	1 2	1 2	1 2	1 2	1 2	1 2
		Group 3	1 2	1 2	1 2	1 2	1 2	1 2	1 2
		Group 4	1 2	1 2	1 2	1 2	1 2	1 2	1 2
		Group 5	1 2	1 2	1 2	1 2	1 2	1 2	1 2
PM	1	Reading							
	2	Group 1	1 2	1 2	1 2	1 2	1 2	1 2	1 2
		Group 2	1 2	1 2	1 2	1 2	1 2	1 2	1 2
		Group 3	1 2	1 2	1 2	1 2	1 2	1 2	1 2
		Group 4	1 2	1 2	1 2	1 2	1 2	1 2	1 2
		Group 5	1 2	1 2	1 2	1 2	1 2	1 2	1 2

Week 2		**DATE**							
AM	**1**	**Reading**							
	2	**Group 1**	**1 2**	**1 2**	**1 2**	**1 2**	**1 2**	**1 2**	**1 2**
		Group 2	**1 2**	**1 2**	**1 2**	**1 2**	**1 2**	**1 2**	**1 2**
		Group 3	**1 2**	**1 2**	**1 2**	**1 2**	**1 2**	**1 2**	**1 2**
		Group 4	**1 2**	**1 2**	**1 2**	**1 2**	**1 2**	**1 2**	**1 2**
		Group 5	**1 2**	**1 2**	**1 2**	**1 2**	**1 2**	**1 2**	**1 2**
PM	**1**	**Reading**							
	2	**Group 1**	**1 2**	**1 2**	**1 2**	**1 2**	**1 2**	**1 2**	**1 2**
		Group 2	**1 2**	**1 2**	**1 2**	**1 2**	**1 2**	**1 2**	**1 2**
		Group 3	**1 2**	**1 2**	**1 2**	**1 2**	**1 2**	**1 2**	**1 2**
		Group 4	**1 2**	**1 2**	**1 2**	**1 2**	**1 2**	**1 2**	**1 2**
		Group 5	**1 2**	**1 2**	**1 2**	**1 2**	**1 2**	**1 2**	**1 2**
Week 3		**DATE**							
AM	**1**	**Reading**							
	2	**Group 1**	**1 2**	**1 2**	**1 2**	**1 2**	**1 2**	**1 2**	**1 2**
		Group 2	**1 2**	**1 2**	**1 2**	**1 2**	**1 2**	**1 2**	**1 2**
		Group 3	**1 2**	**1 2**	**1 2**	**1 2**	**1 2**	**1 2**	**1 2**
		Group 4	**1 2**	**1 2**	**1 2**	**1 2**	**1 2**	**1 2**	**1 2**
		Group 5	**1 2**	**1 2**	**1 2**	**1 2**	**1 2**	**1 2**	**1 2**
PM	**1**	**Reading**							
	2	**Group 1**	**1 2**	**1 2**	**1 2**	**1 2**	**1 2**	**1 2**	**1 2**
		Group 2	**1 2**	**1 2**	**1 2**	**1 2**	**1 2**	**1 2**	**1 2**
		Group 3	**1 2**	**1 2**	**1 2**	**1 2**	**1 2**	**1 2**	**1 2**
		Group 4	**1 2**	**1 2**	**1 2**	**1 2**	**1 2**	**1 2**	**1 2**
		Group 5	**1 2**	**1 2**	**1 2**	**1 2**	**1 2**	**1 2**	**1 2**

Week 4		**DATE**							
	1	**Reading**							
	2	**Group 1**	**1 2**	**1 2**	**1 2**	**1 2**	**1 2**	**1 2**	**1 2**
AM		**Group 2**	**1 2**	**1 2**	**1 2**	**1 2**	**1 2**	**1 2**	**1 2**
		Group 3	**1 2**	**1 2**	**1 2**	**1 2**	**1 2**	**1 2**	**1 2**
		Group 4	**1 2**	**1 2**	**1 2**	**1 2**	**1 2**	**1 2**	**1 2**
		Group 5	**1 2**	**1 2**	**1 2**	**1 2**	**1 2**	**1 2**	**1 2**
	1	**Reading**							
	2	**Group 1**	**1 2**	**1 2**	**1 2**	**1 2**	**1 2**	**1 2**	**1 2**
PM		**Group 2**	**1 2**	**1 2**	**1 2**	**1 2**	**1 2**	**1 2**	**1 2**
		Group 3	**1 2**	**1 2**	**1 2**	**1 2**	**1 2**	**1 2**	**1 2**
		Group 4	**1 2**	**1 2**	**1 2**	**1 2**	**1 2**	**1 2**	**1 2**
		Group 5	**1 2**	**1 2**	**1 2**	**1 2**	**1 2**	**1 2**	**1 2**
Week 5		**DATE**							
	1	**Reading**							
	2	**Group 1**	**1 2**	**1 2**	**1 2**	**1 2**	**1 2**	**1 2**	**1 2**
AM		**Group 2**	**1 2**	**1 2**	**1 2**	**1 2**	**1 2**	**1 2**	**1 2**
		Group 3	**1 2**	**1 2**	**1 2**	**1 2**	**1 2**	**1 2**	**1 2**
		Group 4	**1 2**	**1 2**	**1 2**	**1 2**	**1 2**	**1 2**	**1 2**
		Group 5	**1 2**	**1 2**	**1 2**	**1 2**	**1 2**	**1 2**	**1 2**
	1	**Reading**							
	2	**Group 1**	**1 2**	**1 2**	**1 2**	**1 2**	**1 2**	**1 2**	**1 2**
PM		**Group 2**	**1 2**	**1 2**	**1 2**	**1 2**	**1 2**	**1 2**	**1 2**
		Group 3	**1 2**	**1 2**	**1 2**	**1 2**	**1 2**	**1 2**	**1 2**
		Group 4	**1 2**	**1 2**	**1 2**	**1 2**	**1 2**	**1 2**	**1 2**
		Group 5	**1 2**	**1 2**	**1 2**	**1 2**	**1 2**	**1 2**	**1 2**

Week 6		DATE							
	1	Reading							
	2	Group 1	1 2	1 2	1 2	1 2	1 2	1 2	1 2
AM		Group 2	1 2	1 2	1 2	1 2	1 2	1 2	1 2
		Group 3	1 2	1 2	1 2	1 2	1 2	1 2	1 2
		Group 4	1 2	1 2	1 2	1 2	1 2	1 2	1 2
		Group 5	1 2	1 2	1 2	1 2	1 2	1 2	1 2
	1	Reading							
	2	Group 1	1 2	1 2	1 2	1 2	1 2	1 2	1 2
PM		Group 2	1 2	1 2	1 2	1 2	1 2	1 2	1 2
		Group 3	1 2	1 2	1 2	1 2	1 2	1 2	1 2
		Group 4	1 2	1 2	1 2	1 2	1 2	1 2	1 2
		Group 5	1 2	1 2	1 2	1 2	1 2	1 2	1 2

Appendix Q – Concert List

Billy Joel -
1979 (30) - https://www.youtube.com/watch?v=D-x7VagsVUk
1990 (41) - https://www.youtube.com/watch?v=uBZf0E5jQZU
1998 (49)- https://www.youtube.com/watch?v=eBt73RoUBug
2006 (57) - https://www.youtube.com/watch?v=Y9QIEBubIPc
2014 (65) - https://www.youtube.com/watch?v=zmNW2pYsALo
2019 – (70) - https://www.youtube.com/watch?v=R9IApxU2SyI

Elton John -
1974 (27)- https://www.youtube.com/watch?v=bF14ECixT9I
1989 (43) - https://www.youtube.com/watch?v=C1SoGPNzKos
2001 (54)- https://www.youtube.com/watch?v=HG_q8dO_DRY
2010 – (63) - https://www.youtube.com/watch?v=opaAFsIpnHE
2015 (68) - https://www.youtube.com/watch?v=0JQQPErc-BA
3/16/2019 (72) - https://www.youtube.com/watch?v=Fvc1C6gX4ds

Rod Stewart: -
1974 (29)- https://www.youtube.com/watch?v=rK_wPCQCVRY
1980 (35)- https://www.youtube.com/watch?v=SU-0z2Kive4
1991 (46) - https://www.youtube.com/watch?v=cPvOhPDxeJc
2008 (63) - https://www.youtube.com/watch?v=BYXJ2Y_Qy6Q
2012 (67) - https://www.youtube.com/watch?v=efrniDAxZbA
2018 (73)- https://www.youtube.com/watch?v=B-a3mieMCZY

Bob Dylan -
1976 (34)- https://www.youtube.com/watch?v=aN4DgHh_sXU
1986 (44)- https://www.youtube.com/watch?v=ZfHfkZOeuNM
1990 (48) - https://www.youtube.com/watch?v=faxAEQaMZnM
2000 (58)- https://www.youtube.com/watch?v=NCYJpUIVgXI
2009 (67)- https://www.youtube.com/watch?v=mZwt1R2iMok
2016 (74)- https://www.youtube.com/watch?v=0QTL4nNhzYA

Steven Tyler: -
1980 (32)- https://www.youtube.com/watch?v=7d96X5ZqOVI
1988 (40) - https://www.youtube.com/watch?v=IpzLw8UUtAw
2010(52)- https://www.youtube.com/watch?v=27v6LrUk_o8
2010 (62) - https://www.youtube.com/watch?v=s9feGtUDX3c
2013 (65)- https://www.youtube.com/watch?v=-pOcIv4rsQA
2018 (70) - https://www.youtube.com/watch?v=iJIwzNFA7g4

Tony Bennett -
1966 (40) - https://www.youtube.com/watch?v=tTE7wMut1lM
1974 (48) - https://www.youtube.com/watch?v=7pkzrSOmyWo
1981 (55) - https://www.youtube.com/watch?v=GY-J-z0f5hk
1991 (65) - https://www.youtube.com/watch?v=E5IjP6GXBIo
2002 (76)- https://www.youtube.com/watch?v=7QdvNjOAfUY
2018 (92)- https://www.youtube.com/watch?v=gwFTDx3H7Ho

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Professional Publications

1. **Sloggy, J**., Stemple, J., Rowles, G., & Andreatta, R. (2019). In Support of the Exceptional Voice. *Perspectives on Voice and Voice Disorders*

2. **Sloggy, J.**, & Rowles, G. (2019). Against the Wind: Singers growing Old. *Journal of Singing. 75(5)*, 535-551.

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